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SASKATCHEWAN RESEARCH COUNCIL

29TH ANNUAL REPORT 1975

THE RESEARCH COUNCIL ACT, 1965.
Clause 21, in part, directs that

1. The Council shall on or before the last day of February in each year submit to the Lieutenant Governor in Council a report of its proceedings and transactions during the next preceding calendar year, which report shall contain such particulars as the Lieutenant Governor in Council may prescribe.

2. Every report shall forthwith be laid before the Legislative Assembly if then in session or, if it is not in session, within fifteen days after the opening of the next session.

Regina, February 19, 1976

●

TO THE HONOURABLE S. WOROBETZ

Lieutenant Governor of the
Province of Saskatchewan

MAY IT PLEASE YOUR HONOUR

The undersigned presents herewith, for your consideration, the report of the Saskatchewan Research Council for the year ended December 31, 1975.

Respectfully submitted,

John R. Messer, Chairman
Saskatchewan Research Council

PLEASE ADDRESS CORRESPONDENCE TO

Saskatchewan Research Council
30 Campus Drive
Saskatoon, Saskatchewan
S7N 0X1

SASKATCHEWAN RESEARCH COUNCIL

MEMBERS OF THE SASKATCHEWAN RESEARCH COUNCIL

The Honourable Jack Messer, Chairman
G. J. Gartner, Vice Chairman
D. Bock, Secretary (on leave)
D. Murray, (Interim Secretary)
J. H. Archer
N. Bromberger
E. B. Campbell
B. M. Craig
R. G. Dalgleish
J. E. Fletcher
L. Katz
A. Kavadas
R. E. Lloyd
K. J. McCallum
G. C. Mitchell
D. Pichler

EXECUTIVE OFFICERS OF THE COUNCIL'S STAFF

Director	T. P. Pepper
Administrative Officer	R. E. Melvin

Division Heads

Chemistry	Brad H. Gunn
Engineering	W. H. W. Husband
Geology	R. G. Arnold
Industrial Services	I. S. Evans
Physics Division	J. Maybank

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PROCEEDINGS OF THE COUNCIL

Membership of the Council increased from 14 to 15 during 1975. The Council Act allows a maximum membership of 21.

The Honourable Jack Messer assumed the duties of minister-in-charge from the Honourable Gordon MacMurchy on November 5, 1975. Other changes include the resignations of Mr. Doug McArthur and Mr. Keith O. Saddlemyer and the appointment to Council of Mr. R. G. Dalgleish, Dr. L. Katz, and Mr. R. E. Lloyd. While Council secretary, Mr. D. Bock, is absent on educational leave Mr. D. Murray is serving as interim secretary.

To date, November 17, Council has met in Regina twice during the year, on March 3 and on September 22. The main business of these meetings was to receive the reports of the executive committee, to formulate policy and priorities for the program of the laboratories, to approve the 1975-76 program, and to recommend the 1976-77 program.

The executive committee consisting of the chairman, vice-chairman, secretary and Dr. B. Craig with the director acting as secretary, has to date met six times during the year, on January 20, February 7, April 15, May 15, July 18, and August 22. The main activities of the executive committee were to deal with routine administrative matters of the laboratories and, in conjunction with Council management, to prepare laboratory program details for discussion by Council.

102-00005/

1975 IN REVIEW

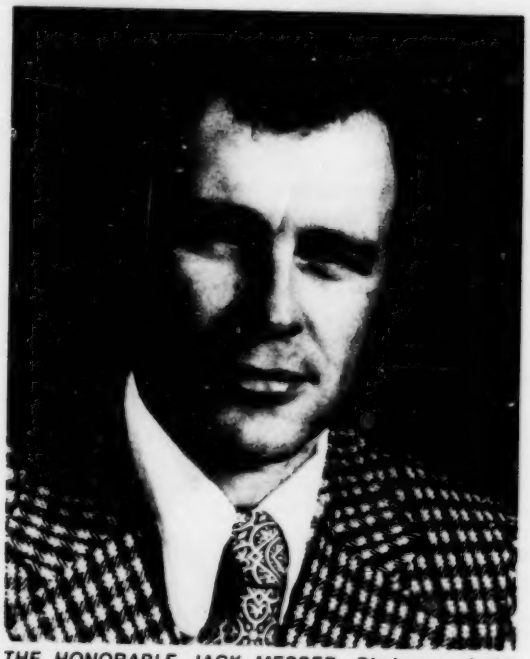
Saskatchewan, a province with a rich resource base but a scant population, a producer of bulky goods which is separated by vast distances from major markets and a region of rapid industrial growth in a high quality environment, poses major challenges to its people. Major contributions to the solution of these problems lie in the realm of science and technology. To this end, the Saskatchewan Research Council was established in 1947 to provide a centre of excellence to which both the public and private sectors can look for advice concerning the special technical problems of the province.

THE HONORABLE GORDON MacMURCHY, past Council chairman.

As Saskatchewan is a dynamic place, it is necessary for SRC to maintain a dynamic posture, investigating new problems, re-investigating old ones as circumstances change, carrying out short-term studies, monitoring ongoing activities and attempting to anticipate long-range problems.

In the 1975-76 fiscal year, the Council's efforts were channeled into five major activity areas:

- Agriculture,
- Resource Development (with major emphasis on the north),
- Industrialization,
- Environment,
- Services.

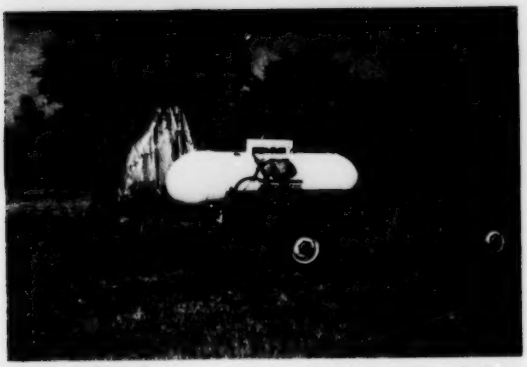


THE HONORABLE JACK MESSER, Chairman of the Saskatchewan Research Council.

Agriculture

Efforts in the agricultural sector are aimed at intensification and diversification of production capabilities to offset the trend towards larger farm size with consequent economies of scale. Survival of prosperous family farms will assure stability of rural population and provide a key to the establishment of agricultural process industries in this province.

To implement its objectives in the agricultural sector the Council has engaged in about a dozen programs, employing in-house staff and the skills of outside agencies. Highlights of some of these programs are presented here.



ADDING AMMONIA to improve the digestibility of straw and low quality hay may permit substantial savings in feed costs by Saskatchewan beef producers. Major studies on use of waste materials as cattle feed are under way at SRC.

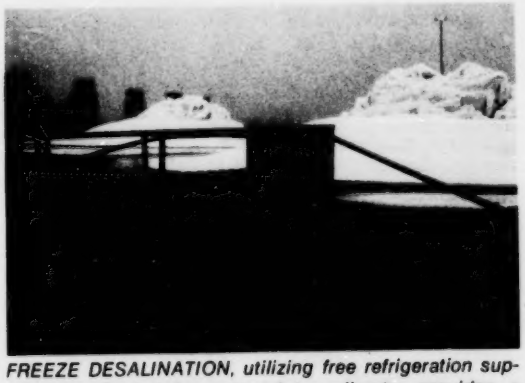
The high cost of feed grain has severely limited the potential of the beef cattle industry recently. Processing of Saskatchewan's annual output of 20,000,000 tons of straw and poor quality hay into a palatable, digestible livestock feed has been the subject of investigation by a team including scientists from the Saskatchewan Research Council, Agriculture Canada, the Western Canada College of Veterinary Medicine and the Department of Animal Science, University of Saskatchewan. Three different processes for augmenting digestibility are under study, backed up by several sets of animal feeding trials employing the various products. Special provincial funding of $36,000 was made available for this work.

Another project relating to animal feed involves the processing of alfalfa to obtain an optimum material. Alfalfa leaves have considerable potential for use as a protein supplement for pigs and other animals that cannot digest high levels of fiber. The more fibrous stem fraction of the plant, after simple processing, is still a useful complete forage for ruminant animals. Work on the technology and economics of these processes involves SRC, the Northeast Alfalfa Dehydrators Association, the University of Saskatchewan and Agriculture Canada.

The rising cost of agricultural chemicals makes the effective utilization of these materials even more important. Herbicides that drift from their targets increase both the cost of farming and the pollutant load on the environment. SRC, with financial support from Agriculture Canada, carried out detailed tests of the effectiveness of new spray nozzle designs and of chemical additives in controlling undesirable chemical drift.

An intensive program of sampling and measuring spring runoff around feedlots in the Pheasant Creek area was undertaken in 1975 for the Saskatchewan Department of Agriculture. The objective of this work is to determine the extent to which effluents from existing feedlots contribute to stream pollution and to evaluate factors such as isolation distances, feedlot populations, soil types and slope in relation to stream pollution.

SPRAYER NOZZLE WEAR is a contributing factor in producing undesirable pesticide drift. Murray Peters uses a photoelectric scanner to investigate orifice wear in farm spray nozzles. Performance of nozzles in relation to wear is further investigated using the patternator apparatus (background).



FREEZE DESALINATION, utilizing free refrigeration supplied by Saskatchewan's winter climate, provides a significant share of the potable water at the village of Frontier.

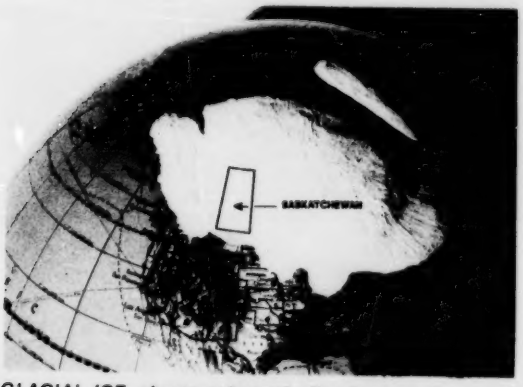
The problem of supplying good quality water, both for animals and household use, remains a

significant one in Saskatchewan's rural areas where natural water supplies are highly saline. To alleviate this problem the Council is in the final stages of demonstrating the economics of using natural freeze desalination to provide potable water. The method can produce good quality water from brackish or saline groundwater at a cost lower than that of other methods under Saskatchewan conditions. During 1975 demonstration units were operated at Armley, Bruno, Blucher, Saskatoon and Frontier. At Frontier, the unit was increased in size five-fold compared to other units and it performed as predicted to contribute significantly to the village's water supply. Financial assistance for this work was provided by the Department of Regional Economic Expansion.

Resource Development

Resource development was the area of greatest SRC activity during the past year, with about $1,000,000 shared among some 30 projects. Northern resource development was singled out for special attention with a suite of projects relating to metallic minerals and uranium. Other major efforts in the resource areas were aimed towards lignite reserves and problems of the potash industry.

Geochemical methods have been employed in searching for uranium in the Duddridge Lake area of northern Saskatchewan. The survey, undertaken with the co-operation of lease holders in the area including Thor Exploration, Brascan Resources and Noranda Exploration entailed the collection of water samples, surficial material, lake sediments and muskeg. Chemical and radiological survey findings were compared. Also, a project was initiated in which the geological setting, mineralogy, age and geochemistry of newly-found uranium deposits are carefully documented as an aid to further exploration.



GLACIAL ICE, shown schematically above as it existed during the Pleistocene maximum, has profoundly influenced Saskatchewan's landscape. The ancient beach, shown below, is part of the Glacial Meadow Lake complex. A compilation of SRC geological studies is a major component of the Meadow Lake Geolog, produced by the Council under contract to the Department of Tourism and Renewable Resources. The Geolog outlines major features of the Meadow Lake Provincial Park area.

A detailed followup survey, investigating some 60 geochemical anomalies located in a 1974 Geological Survey of Canada geochemical program, was an important part of the year's work program. This work was carried out under contract with the Department of Mineral Resources. Another geochemical survey carried out for the Department of Mineral Resources concerned a property on the north end of Nemeiben Lake.

Better knowledge of the distribution and origin of glacial and post-glacial sediments in Saskatchewan's Precambrian area is a likely factor in mineral exploration. To this end, SRC is carrying out mapping of areas 73P, (Lac La Ronge); 74A, (Foster Lake); 64D, (Reindeer Lake South); 63M, (Pelican Narrows) and 63L (Amisk Lake) involving a sampling density of one site per 40 square miles. This work is supported by a contract with the Department of Mineral Resources.

Considerable care is required in the mining of potash to control the movement of salt and potash rock surrounding the mine openings. Both long-term, efficient operation of the mines and mine safety depend upon proper interpretation of the forces existing in the mine walls, pillars and roofs. However, to date adequate instrumentation to measure these forces has not been available and the few existing instruments have never been fully evaluated. Thus, a co-operative program has been organized by the Council to develop a suitable device for measuring *in situ* stresses around potash mine openings. With funding from the Department of Energy, Mines and Resources and the co-operation of Cominco Potash, the Department of Mineral Resources and the Department of Geological Sciences, University of Saskatchewan, SRC had undertaken a program to develop and test instruments at the Cominco mine.

Energy resources are of particular significance to Saskatchewan in view of the demands imposed by our geographic setting. In 1972 the Council began a resource evaluation program that led to a preliminary estimate of the lignite resource of 5.7 billion tons. During the field program, geophysical logs, sample descriptions and chemical analyses were obtained from borehole samples. Detailed compilation of data concerning individual coal seams with respect to quality, thickness and structure are being placed in a computer data base. This material will assist decision makers in framing long-term policies concerning the coal resource. The lignite resource program enjoyed participation and funding from the Department of Mineral Resources, and the Department of Energy, Mines and Resources as well as the Saskatchewan Research Council.

Another aspect of SRC's lignite program was concerned with evaluating coal leases for the Saskatchewan Power Corporation. Properties at Coronach (the fuel supply for the Poplar River plant) and Estevan (the fuel supply for the Boundary Dam plant) were subjected to detailed drilling.

Industrialization

Industrialization is the subject of more than 20 SRC projects. Various groups of projects relate to specific mineral industries, technical assistance for existing industries, transportation, and upgrading of management skills.

Large quanities of carnallite are associated with Saskatchewan's potash deposits. It can be processed to produce magnesium chloride which in turn can be used to make magnesium metal, or magnesium oxide. The latter is a major ingredient of high grade refractory bricks. Either product requires a very pure grade of magnesium chloride. A market survey conducted by the Department of Industry and Commerce indicated interest in a source of high grade magnesium chloride so the department and Saskatchewan Minerals placed a contract with the Council leading to the development of a satisfactory process for producing the required chemical.

With increasing industrialization in Western Canada, refractory materials are in greater demand. Practically all refractories for steel mills, smelters and oil refineries are imported into Canada, so consideration has been given to developing commercial production of refractories in Saskatchewan using local clays. Preliminary tests have shown that it is feasible to make ladle brick for steel mills from Saskatchewan clays.

Welding technology is a component of many Saskatchewan manufacturing operations. Access to information concerning weldment design and materials selection has been particularly difficult for short-line farm machinery firms located in smaller centres. To alleviate this problem SRC, with the co-operation of the National Research Council and the Canadian Welding Improvement Bureau, has launched a program to upgrade applied technology in this area. A number of Saskatchewan firms have already realized considerable savings through product design improvements, better materials selection and optimum use of welding techniques. An important element in this program is a series of courses for engineers, foremen and supervisors designed to bring them up to date on the most recent developments in welding.

Under an agreement with the National Research Council, SRC operates a free and confidential technical information service that has serviced clients in a broad spectrum of Saskatchewan industries including agriculture, construction, forestry, manufacturing and mining. An offshoot of the technical information program is the pilot project in computerized information retrieval under which, on a fee-for-service basis, SRC can access highly specialized literature archives resident in computers at certain North American centres.

Industrial engineering involving plant layouts,

A CRITICAL PATH NETWORK using the "planalog" technique was established by SRC industrial engineer Robert Levesque to schedule work for 46 employees at a Saskatchewan house building plant.

financial and marketing analyses, and organization design, was again offered to Saskatchewan firms under the NRC-assisted program. As well as specific assistance to individual clients, industrial engineering activities included preparation of a number of specialized publications and sponsorship of a senior management seminar. The 1975 seminar featured Mr. Mitchell Fein, a leading industrial engineer, who dealt with problems relating to motivation and incentives.

Movement of materials in northern Saskatchewan is not easy. Rugged terrain, long distances, and relatively low freight volume deter construction of expensive all-weather roads. During 1975 the Council organized a field demonstration of an air cushion raft in northern Saskatchewan that

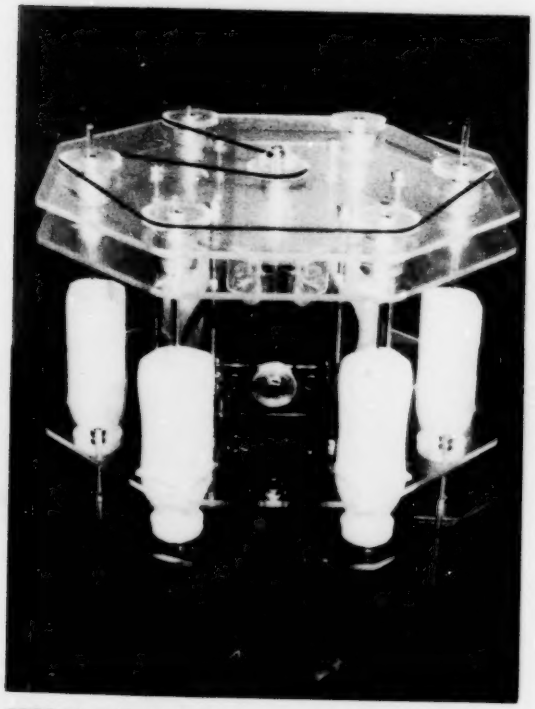
ICE CROSSINGS are important winter transportation links in many parts of Saskatchewan. SRC, under contract to the Department of Highways and Transportation, investigated pressures produced by vehicles moving at various speeds on the ice near Riverhurst. The deflectometer (foreground) was especially developed by SRC for this study.

produced considerable interest. Plans are underway to test an air cushion assisted logging transporter which has the potential for reducing the cost of northern roads.

Winter river crossing poses problems to vehicle operation throughout the province. At the request of the Department of Highways and Transportation, the Council investigated the feasibility of ice bridges across Lake Diefenbaker during the winter of 1974-75. In co-operation with the highways department, Council staff assisted in the operation of a full-scale bridge across Lake Diefenbaker at Riverhurst. The bridge was very successful, revealing certain features of ice behavior which will have a profound effect in changing some traditional assumptions concerning loading of ice.

Environment

Saskatchewan's relatively unsullied environment requires careful protection in the face of expanding development. To meet this need, SRC is expanding its role in environmental assessment and monitoring. This is a task for which the Council is almost ideally suited because of its situation, the high level of awareness of Saskatchewan's environmental problems among its staff, and its strictly objective role as a research agency.



SPECIAL RADIOCHEMICAL ANALYSES require special equipment that may not be commercially available. To determine tiny quantities of radioactive Polonium-210 occurring in our environment, SRC's Chemistry Division developed a method in which the Polonium self-plates itself to silver discs from slowly stirred solution. The special stirring apparatus was developed by the Council's precision instrument facility. The unit has the high reliability and speed stability required for this application.

During 1975 the Council has carried out a number of environmental impact assessments on behalf of clients in both the public and private sectors. While the information obtained in these studies is the property of the Council's clients and is confidential as far as SRC is concerned, much of the key environmental information will undoubtedly reach the public through Environment Saskatchewan's public inquiry process, thereby heightening general awareness of our province's environment.

A non-destructive use of the environment, generation of wind power, was the subject of a contract initiated by the Saskatchewan Power Corporation. Other programs relating to the atmospheric environment include appraisal of air pollution monitoring equipment for incorporation into future environmental impact assessment studies, preliminary investigation of solar energy potential, and work towards modification of ski slope snow-making equipment to increase the recreational capability of Mount Blackstrap.

The accumulation of vital baseline data concerning groundwater quantity and quality continued during 1975. A network of 40 observation wells distributed throughout the populated area of the province was a major element in describing the behavior of the resource. Knowledge gained from the monitoring network, coupled with water quality data from some 3,000 wells, are valuable tools in the solution of rural water supply problems. Urban areas too benefit from this program which furnished basic information for the Yorkton and Regina aquifer evaluations carried out for Environment Saskatchewan and the study of Moose Jaw sewage effluent for irrigation purposes.

Services

Service work is an essential ingredient of the Council's program to meet its in-house needs for high technology backup for a sophisticated research program. When the SRC workload allows it, Council facilities are made available to clients in Saskatchewan and elsewhere on a fee-for-service basis.

The expanded SRC electronics laboratory constructed a novel simulator of the Saskatchewan Power Corporation's electrical distribution system. The Council's precision instrument shop constructed and sold six water level recorders of an advanced design to an out-of-province organization.

During 1975, chemical analytical services were provided for a number of operations including rapeseed processing plants, pulp mills, potash mines, oil refineries and uranium mills. Several major instruments were acquired to upgrade facilities. New equipment was also added to determine trace concentrations of certain radioactive

materials. SRC's contract with the Archaeological Survey of Canada for operation of a radiometric dating service continued.

Another aspect of SRC's service program includes granting monies to further university research in areas of significance to the province's economy. A total of 15 grants totalling $75,000 were made to the universities during 1975.

SRC staff, as individuals, perform services for the scientific community and for a wider scope of society through their participation in scientific, professional and administrative bodies. Various committees of the National Research Council, Agriculture Canada, the Saskatchewan Department of Agriculture, the Department of Energy, Mines and Resources, the World Meteorological Organization, the Kelsey Institute, numerous university departments and inter-agency committees are among the bodies having participation by Council staff.

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PROGRAM OF THE COUNCIL'S STAFF

REPORT OF THE CHEMISTRY DIVISION

Brad H. Gunn, Head

INTRODUCTION

The object of the Chemistry Division during the past year has been to concentrate on a few projects which were selected on the basis of relevance to the economy of the province. The program is essentially one involving the application of research and in consequence suffers from a shortage of fundamental research.

The report consists of summaries of the major activities.

Assessment of Potential Cold and Drought Resistant Crops for Saskatchewan

A small amount of further work has been conducted on cold and drought resistant plants for possible crop development in Saskatchewan. Several plants of the Goosefoot family have been evaluated in studies reported previously. One of the plants which appeared of interest for Saskatchewan was quinua (*Chenopodium quinoa*) — formerly an important food grain crop of the Andes region of South America. Analysis of seed obtained from South America indicated that it contained very low amounts of saponins. Previous work had indicated that if large amounts of toxic saponins were present the material should be washed before feeding. Because this variety had very low amounts of saponin it was decided to evaluate its performance in turkey poults without processing. The trials were conducted by Dr. R. Salmon of the Swift Current Research Station of Agriculture Canada. The results indicated little difference in feed performance between the experimental diets containing quinua seed and the standard control diet. Compared with the control diet the feed value of the experimental diets was somewhat less, although the difference was not statistically significant. However the intake of the turkey poults on all diets was somewhat lower than expected, so it is felt that these trials should be repeated to obtain more reliable statistics. These initial results do suggest, however, that the particular variety of quinua used in this trial may be acceptable as a protein and energy component of the diet of poultry without further processing. The amino acid composition of the quinua are of high quality. The content of protein was approximately 14 per cent.

Processing Alfalfa to Increase its Value as Animal Feed

Leaves are higher in protein and lower in fiber than the stems of the plants. A leaf fraction which is separated from the stems is probably a satisfactory protein supplement for pigs and other livestock which cannot digest high levels of fiber. Such a fraction may also have a future (probably after further processing) for human consumption. The stem fraction remaining after the removal of the leaf fraction is still acceptable as a complete forage for ruminant animals. It may, however, be improved by various treatments such as the addition of small amounts of sodium hydroxide.

This project has been conducted jointly with the Animal Science Department of the University of Saskatchewan, and with active support from the Northeast Alfalfa Dehydrators Association and the Melfort and Saskatoon Research Stations of Agriculture Canada. Initial laboratory and pilot plant experiments indicated that products with up to 30 per cent protein and as low as 14 per cent fiber could be obtained by separating the leaves from the stems of dried alfalfa using simple physical techniques.

Air classification can be used to separate the higher leaf fraction from the heavier stem fraction. It was more practical at the present time to use a crushing and screening technique to supply material in sufficient quantities for feeding trials. The leaf fraction is being fed to pigs while the stem fraction is being fed to sheep. In the feeding trial with sheep, stems from high quality alfalfa are being compared with those from average quality alfalfa. These are being compared with average quality stems which have been treated with a small amount of sodium hydroxide. There are two objectives to the feeding trial; (1) to determine whether the high quality material is sufficiently superior to the average quality material to justify cutting at the earlier stage of maturity, (2) to determine whether or not the improvement in digestibility by treatment with sodium hydroxide is sufficient to justify the added costs.

Processing Farm Wastes to Supplement Forages for Cattle

Straw is the most abundant farm waste in western

Canada. Simple processes utilizing straw for farm scale and feedlot scale operations have reached a stage of development when a major feeding trial with cattle is going forward. This project enjoys the concerted effort of a number of agencies: the Animal Science Department of the University of Saskatchewan, the Melfort and Saskatoon Research Stations of Agriculture Canada and the Saskatchewan Department of Agriculture.

Initial experiments and consideration of the capabilities of existing farm and feedlot equipment, as well as the costs of processing, put a practical limit on the number of treatments. The following three were selected:

1. Straw treated with 2 to 5 per cent ammonia (either anhydrous or aqueous);
2. Chopped straw treated with 3 to 5 per cent sodium hydroxide (in solution) and subsequently pelletted.
3. Chopped straw treated with 2 per cent sodium hydroxide plus a 2 per cent calcium hydroxide in sufficient water to give a final moisture content of 50 to 60 per cent, followed by ensilaging for at least one week.

Other factors which are difficult to assess but are recognized as highly significant are the choice of cereal (wheat, barley or oats), the variety and a number of management considerations such as maturity at time of swathing, the effect of weathering, etc. Neepawa wheat straw was used for a comparative trial with steers. The digestibilities of all three treatments were 50 per cent or higher compared with 43 per cent for untreated straw.

In the sheep digestibility trials, ammoniated straws from wheat, oats and barley all showed marked improvement in digestibility and in feed intake over untreated straws. The ammonia treated Bonanza barley and Kelsey oats had digestibility of about 50 per cent. No significantly favorable results were obtained with sodium hydroxide treated straw, nor with sodium and calcium hydroxide treated straw.

Laboratory results and digestibility trials with cattle and sheep indicate that the ammonia treatment of straw is initially superior to the others.

Scaled up procedures for treating straw and feeding cattle are being undertaken at the present time.

Developing Processes for Leather Production To Meet the Needs of the Handicraft Industry

In the previous Annual Reports of the Research Council mention was made of the development of a simple process for tanning deerskins and other similar hides to give a leather comparable in properties to Indian smoked tanned leather, which might be useful for the handicraft industry in the province. During the past year a hundred hides were processed by a commercial tannery in Ontario using the basic method developed in Saskatchewan. The hides were fleshed at the Research Council and were then sent to Ontario for further processing. The leather produced on a pilot scale has had a favourable reaction from handicraft workers. It is being further evaluated by various handicraft groups with the objective that if the leather meets the needs of the handicraft workers, larger scale runs will be done this year to confirm the initial pilot scale results. Physical tests on the leather (done under contract by the Ontario Research Foundation) indicated that the leather was satisfactory as far as physical strength tests were concerned. The needle penetration properties, i.e. how easily a sewing needle can penetrate the leather, indicated that this leather was comparable in ease of sewing to Indian smoked tanned leather. If the leather meets the requirements of the handicraft workers and of the consumers, the next stage would be to consider whether certain steps in the processing might be done in Western Canada. The evaluation part of this project is being conducted by the Saskatchewan Indian Arts and Crafts Committee, and, in Alberta, by the Department of Indian Affairs and Northern Development.

Related to the above is a contract project with a major food processing company. This has led to the establishment of a small pilot plant for evaluating processing of animal products with the object of establishing a processing plant in Saskatchewan.

Monitoring and Protecting the Environment

The past year has been one for wrapping up major programs in environmental baseline assessment initiated the previous year. The second half of the environmental field program carried out in connection with the uranium development of Amok Ltd. has been completed and a final report prepared.

The environmental assessment of changes which have occurred in Tobin Lake since its formation has been completed. We have also been called on to monitor environmental aspects of the Gulf Minerals Ltd. operations at Wollaston Lake on a routine basis. More recently we have been requested by the Wascana Center Authority to monitor the algae control program on Wascana Lake, in preparation for the Summer Games.

Two other small consulting contracts have been completed. One involved identification of benthic organisms and the preparation of a report for the Churchill River project. The other was an environmental impact assessment of a proposed highway from Buffalo Narrows to Dillon in northwestern Saskatchewan for the Department of Northern Saskatchewan. While the latter was not a large contract it serves as useful experience for an expanded program on the environment.

A questionnaire survey of municipal solid waste disposal was concluded during the winter of 1975. The information indicated that there is a need for better disposal methods in many communities and revealed a considerable potential for recycling such materials as glass, metal and paper.

Present activities are centered on preparing proposals for new environmental studies in the north. These are connected to both new and existing mining activities. We are optimistic that the strong demand for our environmental services will be continued.

Consulting Services in Industrial Minerals

During the past year there has been an increased number of inquiries on inorganic chemical processes. Some of these have required a day or less to answer. Others have been sufficiently significant to require considerable time and have been performed under contract. Usually basic information of a helpful nature is available in the literature or from reports of studies performed in our own laboratories as far back in time as 10 to 15 years.

Services

During the past year there has been a large increase in the demand for analytical services. This is attributable to new environmental monitoring requirements, to the expansion of existing industries and to the establishment of new ones. Routine monitoring entails the chemical analyses and identification of discharged wastes from such industries as rapeseed processing plants, pulp mills, potash mines, oil refineries and uranium mills. Chemical analyses are being performed for Saskatchewan industries as an aid in solving processing problems. On other occasions they are being performed to determine purity and confirm quality of finished products. On several occasions a member of the analytical staff has worked at plant site for the purpose of solving analytical problems, training staff and selecting appropriate analytical procedures.

To meet the increased work load, additional laboratory technicians have been hired and several new analytical instruments have been purchased. A CHN (carbon-hydrogen-nitrogen) Analyzer with an electronic micro-balance and a research grade atomic absorption spectrophotometer (Perkin Elmer 503) were the major acquisitions. The former is used mainly for analyses of coal, lake sediments, animal feeds and similar solid samples. The new AA spectrophotometer serves to speed up the processing of samples as well as lowering the limit of detection for trace elements.

The radiochemical facilities will be expanded by the acquisition of a low background, gas flow proportional counter which is presently on order. The new apparatus will permit the determination of certain beta-emitting radionuclides which cannot be analyzed at trace levels with present equipment. It will also increase capacity for processing samples containing alpha-emitting radionuclides.

The carbon dating facility is functioning at full capacity with minimum down time and with reduced manpower. The facility is co-operatively operated with the Archaeological Survey of Canada, National Museum of Man.

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REPORT OF THE ENGINEERING DIVISION

W. H. W. Husband, Head

Changing Brackish and Saline Waters into Potable Water, Using Natural Refrigeration

In much of the settled area of Saskatchewan, brackish ground water is the only well-distributed, reliable water source. The salt content of this water must be reduced to provide a good potable supply. Commercial desalination methods are available, but operating costs are high at capacities suitable for small communities and individual farmers. Over the last fifteen years the Division has investigated simple, cheap methods of desalinating water by natural freezing.

Spray freezing is being studied now. With this method, brackish water is sprayed continuously onto an unconfined area during the winter. By controlling the spraying rate the temperature of the resulting ice mound can be maintained near the freezing temperature and the salts will remain dissolved in brine surrounding ice crystals which are almost pure water. The brine is heavier than ice and will drain to the bottom of the mound during the winter and will be flushed out by the first melt water in the spring. The brine can be discarded and the remaining ice melted and stored for use as potable water.

During the 1974-75 winter, spray freezing trials were conducted on a synthetic brackish water near Saskatoon and on natural brackish ground waters at Armley, Blucher, Bruno and Frontier. At all sites two units with independent spray heads were operated. In addition, at Frontier a larger spray area with five spray heads was operated. These trials covered a range of brackish water types and climatic conditions. Yields were good, generally more than half of the input water was recovered as water containing less than one-half of the salt content of the input water. The multiple unit at Frontier gave results similar to those from the units with only one spray head.

At Frontier, the product water from the three units was pumped to an infiltration pond constructed near the village's shallow wells. Infiltration was successful and the water has partially recharged the shallow aquifer.

During the 1975-76 winter, tests are being repeated at all sites to continue investigating the effects which weather variations have on the results.

This study has been funded under a joint federal-provincial ARDA program.

Determining the Ways in which Agriculture Might Pollute Surface Waters

According to 1974 statistics, there are over 3 million cattle and over 1.3 million hogs and sheep in the Province of Saskatchewan. Most of these are located in a small number of feedlots and particularly within the effective drainage area of the Qu'Appelle River system. The disposal of animal wastes is a significant problem which is causing concern. Agriculture is increasingly alleged to exert a detrimental influence on water quality. Effluents from farm animal production areas are particularly susceptible to generalizations that mark them as a major contributor to surface water pollution.

Frequently results obtained from studies done in totally different environments are applied to the situation in Saskatchewan to provide data on the significance of pollution. Knowledge concerning the actual pollution imposed on streams from point and diffused sources of animal wastes is necessary to properly assess the problem and formulate meaningful waste control, treatment, and disposal requirements for surface water protection.

A program to obtain the relevant field data was requested by the Family Farm Improvement Branch of the Department of Agriculture and was initiated during the spring of 1975. The objectives of the investigation are to determine the extent to which effluents from existing feedlots in the Pheasant Creek basin contribute to stream pollution and to evaluate the factors such as isolation distance, feedlot population, soil, and slope of the feedlot basin which govern the amount of pollution from the sources.

The study also emphasizes the independent contribution to the pollution of the river system by the transport of sediments and fertilizers from agricultural lands.

Water quality and stream flows were measured at selected sites in the Pheasant Creek basin. Automatic samplers were used at main sites and numerous grab samples were also obtained to provide adequate coverage. Stream flows were

measured using dye fluorometry and the nutrient loading into the river at various points was computed.

Natural fluorescence due to the bio-organic pollutants from feedlots was measured to show a strong correlation with the total organic carbon in the samples. It is proposed to develop this technique to monitor agricultural pollution and for remote sensing purposes. The investigation will be extended to develop a water quality model and to provide data on the efficiency of various waste disposal methods.

The Value of Sloughs and Potholes

Sloughs and potholes form an integral part of Prairie topography. The density of wetlands vary from a few to as many as 200 per square mile.

They are sources of fresh water, serve as the most vital habitats for the production of waterfowl, and are frequently drained to reclaim the land for agricultural production. There has been recently an upsurge of fish farming activity in permanent sloughs, and wetlands have been considered for disposal of agricultural wastes.

The flora and fauna in and around the sloughs reflect the ambient environmental quality. Recognizing their growing ecological importance and multipurpose use, a program to study the hydrology of Prairie sloughs was undertaken, which is a Canadian contribution to the International Hydrological Decade. Twelve years of hydrometeorological data have been compiled from about 125 sloughs near Floral, Swift Current, Fort Qu'Appelle, Wilkie and Melfort. The field program ended in 1975 and the data are being analyzed to regionalize the water losses due to evaporation, seepage and transpiration in the settled part of the province.

A new method of computing evaporation from water bodies has been developed and successfully applied to lakes and reservoirs in Saskatchewan. Thermal stratification and the effect of shelter on evaporation have been studied.

Significant developments from the study have been reported in the Journal of Hydrology and in Water Resources Research. Work is continuing on the economic analysis of the value of wetlands to the province as sources of water, recreation and in producing crops from the drained lands. The study will generate hydrologic data to assess the role of wetlands in the disposal of agricultural wastes.

Technical and Economic Information for Transporting Solid Materials Through Pipelines

Large quantities of solid raw materials are transported over long distances in Canada, either for export or for further processing within the country. In other countries, private industry has developed the use of pipelines to transport economically coal, iron ore, limestone, and mineral concentrates. Solids pipelines normally convey these material as a mixture of solids in water. If a fluid for which there is a market at the end of the pipeline is used as the conveying fluid, there would be significant economic advantages.

In Canada crude oil conceivably could be used as conveying fluid for which there is a market at the end of a solids pipeline. Most of Canada's proven oil and coal reserves are located in Western Canada, while the major domestic markets for both commodities exist in Ontario and Quebec. As no long distance coal-in-oil pipeline was in existence in 1973, the Transportation Development Agency awarded a contract to the Council to investigate the pipeline transportation of thermal and metallurgical coal in crude oil. Coals and crude oils with markets in central Canada were selected, representative samples were obtained, and a series of tests in a 5 cm diameter pipeline was carried out.

The study was completed in 1975. Means of separating the coal from the oil at the end of a pipeline were investigated and the products were examined to determine if pipelining resulted in any deterioration.

The results of the overall study indicate that transportation of coal and crude oil in a pipeline is technically feasible, coal properties are reasonably unaffected, but the quality of crude oil is reduced and would require considerable upgrading before it would be acceptable as refinery feedstock.

Engineering Data for Design of Ice Bridges

Several communities in Saskatchewan are situated close to ferries which have become an important part of their life-style and communications. These are seriously disabled when the ferries become inoperative during the winter months, and there is a growing demand for the establishment of ice bridges to remedy the situation. If such ice bridges are to become an integral part of the road network during winter, it is most important to establish adequate safety practices.

The Department of Highways and Transportation commissioned the Council to conduct an exploratory study on an ice crossing during the winter of 1974-75 with the aim of developing safety procedures that could be applied generally to ice bridges in the province. Accordingly, an ice crossing was constructed across Lake Diefenbaker close to the line of the Riverhurst ferry. The Council collaborated with DOH in conducting daily safety checks and evaluating the behaviour of ice under moving loads. The crossing was opened to public use for several weeks without mishap.

The tests constitute the first systematic study of moving loads on ice, and have demonstrated certain features of ice behaviour which will have a profound effect in changing some traditional assumptions about loads on ice. The Riverhurst ice crossing was found to be exceptionally safe and stable, largely due to the great depth of water. This same factor makes it unwise to extend the Riverhurst findings to ice crossings over shallow water, which would demand a supplementary study.

Enviromental Studies Related to Industrial, Agricultural, and Public Utility Development

In recent years there has been considerable interaction of man with his environment. Agriculture, livestock operations, water resources development, industrial growth and recreational activities are but some of the areas where the interaction has been significant. Saskatchewan has been no exception. Its agricultural economy depends on the exploitation of land and water resources for maximum production.

Large tracts of land are being cleared to develop pastures. Clear cutting around recreational areas could produce detrimental effects on the water quality and induce development of algal growth. Large scale drainage of sloughs creates new hydrologic patterns which might adversely affect the land and highway structures. Knowledge on the effect of these changes on the hydrology and water quality of the affected areas is lacking in the province.

An in depth study is underway to collect background data on the quality of the environment before, during, and after development to make an objective assessment of the impact. Land clearing around Iroquois Lake, Manito Lake, Royal Lake and Spiritwood has been considered for possible effects on the snow accumulation, snowmelt and water quality of runoff. Background data on land use, topography, soil and meteorology of the areas have been collected. Statistical analysis of available hydrometeorologic data will be done to estimate trends. A preliminary report which includes these data and results from similar studies in the Prairies will be prepared to design field investigations.

Recovery of Magnesium Sulphate from Alkaline Lakes

Saskatchewan has vast quantities of saline resources in the prairie evaporate formation (salt, potash, carnallite) and in alkaline lake brines (sodium sulphate, magnesium sulphate). Recovery, upgrading and marketing of these compounds are complicated by the mining problems, the dilute nature of the brines, and the costs of separating one compound from the others.

A unique method of recovering the magnesium compounds and separating them inexpensively has been proposed as a direct result of the water desalination program at the Council. Ten million tons of magnesium sulphate exist in Big Quill Lake in east central Saskatchewan. This material is a valuable chemical used in the pulp and paper industry.

Under funding from Saskatchewan Minerals and a CANMET research agreement, a laboratory study during the year showed that freezing of Big Quill Lake brine results in recovery of a concentrated brine, sufficiently enriched in magnesium sulphate to make further commercial processing practical. Subsequently, an outdoor large-scale test has been initiated to study natural freezing of Big Quill Lake brine using the technique previously developed at the Council for spray-freeze desalination of water. The advantage of the technique is that the natural cold weather of Saskatchewan winters provides a practically unlimited amount of refrigeration at no energy cost. The test will be carried out over three winters to provide the technical data for technical and economic studies concerning the final processing and sale of a magnesium sulphate product.

Resources Available in the Big Quill Lake Area

The Big Quill Lake basin is one of the largest internal drainage basins in Saskatchewan, covering 1,000 square miles. The brine in the lake contains 10 million tons of sodium sulphate and a similar quantity of magnesium sulphate. These salts at current market prices would have a gross sales value of half a billion dollars.

Since 1966 the Council has been investigating the water balance of this large, shallow lake in sufficient detail to make sound conclusions and to plan the development of its resources such as recovery of the salts in the brine, and use of fresh water for municipal, agricultural, wildlife and recreational purposes.

Basic data have been obtained on the volumes of water entering the lake from spring runoff, groundwater inflow and precipitation. Estimates of these parameters back to 1921 have been made to assist in predicting future lake conditions. The sources of the salts are being determined by drilling programs and ground, airborne and satellite surveys. The project should be completed in 1976.

The data being collected are being used in environmental impact assessments for drainage and storage programs of the Department of Agriculture.

Technical Assistance to Industry Using Pipelines

During 1975 a number of studies were undertaken on a contract basis for industrial clients with an interest in pumping solids through a pipeline. The behaviour of tailings and mineral concentrates as

slurries in a 5 cm diameter pipeline were studied. Measurements were made on the comparative wear rates of sand slurries in pipes made of various materials.

Establishment of a Highway Test Track In Saskatchewan

Highway materials and constructional techniques are continually being improved and developed. This is a very slow process: a new pavement design must first be installed as a test section on the public highway, then several months or years must elapse before it is possible to draw any useful conclusions. There is an obvious need for a special test facility which would reproduce typical highway conditions in a controlled manner, with the additional feature of simulating intensive vehicle use. In this way, the performance of a new pavement design could be established within a few weeks instead of months or years.

It is surprising that there is no such facility in Canada, and that test track projects have to be subcontracted to facilities in the U.S.A. The provincial Department of Highways and Transporation have been particularly active in developing new highway designs and have suffered more than other provinces from the lack of suitable test facilities. Therefore, they have commissioned the Council to design and estimate the cost of an indoor test facility with full environmental control, intensive instrumentation, data acquisition, data processing and simulated intensive vehicle loading. The exercise was completed in June 1975 and the design has been submitted for financial approval. If this is forthcoming, the Council will be supervising all stages of construction and installation up to completion of commissioning tests.

Recovery of Minerals by Solution Mining

Solution mining is a technique used in recovering soluble minerals by injecting a solvent such as water into an underground mineral deposit and removing the solution of dissolved minerals to the surface for processing. In Saskatchewan minerals such as salt, potash, and carnallite can be recovered by solution mining techniques without the costs and hazards of deep shafts and mines.

Past studies at the Council have investigated the economics and engineering aspects of solution mining compared to shaft mining of potash, and laboratory studies of the dissolution rates of potash ore. Through a CANMET research agreement with the Council, Dr. J. H. Masliyah of the University of Saskatchewan conducted laboratory experiments to determine turbulent mass transfer characteristics for an idealized model of a solution mine cavity. These results were correlated with previous data at the Council to yield a complicated theoretical picture of mass transfer in a solution mine.

Under a further CANMET research agreement a computerized empirical model of a solution mining operation was developed for application to recovery of potash and carnallite (a magnesium salt) in Saskatchewan. Investigations showed that once the geochemistry of a potash or carnallite deposit is well established, the computer model would be useful in analyzing the feasibility and development of solution mining ventures. However, limitations made evident in comparing predictions by the model with past solution mining experiences indicate that studies on an actual solution mine are necessary in evaluating this method of mineral recovery in Saskatchewan.

Future studies in solution mining at the Council will involve assessing the costs and feasibility of construction and operation of a field-scale solution mine.

Predicting the Amount of Water Available From Spring Runoff in Small Drainage Basins

Small drainage basins provide water through snowmelt runoff to dugouts, and rural water storage projects. Designing of culverts and bridges require reliable data to estimate peak and total flows. Very little is known of the hydrology of small agricultural watersheds less than 10 square miles in area in Saskatchewan and nor has the influence of land use on the water yield been fully investigated. Runoff curves and return periods of flood peaks computed for a given area have to be corrected for man-made changes on the land. Changes in the peak and total yields invariably affect the water quality of streams.

The program was initiated to provide necessary hydrologic data on small drainage basins and to develop methods to estimate peak and total flows. It was accepted as a Canadian contribution to the International Hydrological Decade in 1967.

Data collected from watersheds established by the Council near Floral, Delisle, Wilkie and Wynyard were analyzed and a simple watershed model was developed to describe the hydrologic behaviour of watersheds. This has been extended to larger drainage basins ranging in size from a few square miles to thousands of square miles. Prediction methods developed from the model are being tested with ungauged and gauged watersheds. Influence of land use on the accumulation and melting patterns of snow cover was investigated by extensive snow surveys. Feasibility of using snow fences to increase the water yield has been studied by field trials. A technique to measure stream flows using a fluorescent dye has been successfully used for gauging streams. The entire instrumentation required for this field operation was designed and fabricated at the Council.

Data collected from a dugout survey initiated in cooperation with the Family Farm Improvement Branch of the Department of Agriculture were analyzed to obtain information on the nature and

magnitude of water demand, problems due to silting and other pertinent factors that would help to assess the adequacy of farm water supply.

The watershed model will be improved to generate data on regionalizing watershed behavior in the province.

Technical Assistance to the Sodium Sulphate Industry

Five companies produce sodium sulphate (salt cake) at six locations in Saskatchewan. As most of the companies are small, they cannot afford to undertake research and development to protect their future. This function has been assumed to a certain extent by the Council and staff provide technical assistance to the companies when required.

During 1975 some undeveloped sodium sulphate deposits were investigated. Large reserves exist in the brine of Big Quill Lake which is too dilute for conventional methods of recovery. Methods to concentrate the brine by natural methods such as freezing and, or, solar evaporation have been proposed and are under study.

Ceramic Research Required for the Development of Saskatchewan Clays

Saskatchewan has large quantities of many types of clays suitable for ceramic purposes. To exploit this natural advantage, the Council has maintained a continuing program of applied research devoted to examining, proving up, and finding uses for Saskatchewan clays and other non-metallic minerals. Efforts are directed toward projects which, at the time, appear to have the best prospects of industrial development. In this regard, contracts with the Department of Industry and Commerce have been most helpful.

During 1975 efforts were directed mainly to the selection of a Saskatchewan clay suitable for making ladle brick, a product not made in Canada. Ladle brick are used for lining vessels to contain molten steel in steel mills. They need not be highly refractory (PCE of 20-23) but must soften slightly and expand at the temperature of use; a linear expansion of 10-16 per cent after 5 hours at 1290° C is guaranteed by two American manufacturers. These properties keep the joints between brick tight in use.

The lack of scientific literature on the subject was a major difficulty in the study. However, this has been more or less overcome. Several samples of Eastend plastic clays appear, on the basis of measurements to date, to expand suitably on reheating. Industrial interest has been expressed.

Other subjects studied during the year include the extraction of cenospheres from Boundary Dam flyash, the examination of clays submitted by the Department of Mineral Resources, the magnetic upgrading of Saskatchewan kaolin, reconstruction of the way in which Plains Indian pottery was made, and studies of why bentonitic clays crack upon drying and what can be done about it. A paper on the last subject was read to the western section, Canadian Ceramic Society, as its annual meeting in Regina in September.

Measuring Urban Runoff from Major Storms

During the design of the Idylwyld Underpass in Saskatoon, the consulting engineers could not find suitable Saskatchewan data on storm intensities, duration and return periods. After construction was completed the storm drainage system was instrumented to obtain instantaneous rainfall and storm water outflow data which will be used to model storm intensity information. Five years of data have been collected.

The purpose is to obtain sufficient data on the relationships between urban runoff and storm intensities and durations under the conditions of Saskatchewan towns and cities. The data will be made available to city engineers, consulting engineers and highway engineers so they can determine more accurately the cost/benefit ratios for various levels of drainage and sewer designs.

This project relates to a much larger problem — that of designing storm sewers for urban areas where much of the area is covered with pavement and additional storm water from new housing development will be added to the existing urban system. The Idylwyld installation is one of the most detailed field studies of the general problem in Saskatchewan. The system is quite versatile and is flexible enough to take up new objectives. It could provide information on runoff from paved and unpaved urban areas, flow patterns for various storm durations and storm intensities, the effect of urbanization on the sediment load and design criteria for sewers and pumping stations.

Design of Water and Sewer Systems for Northern Saskatchewan

The program of community development in northern Saskatchewan has raised a number of questions concerning the best and most suitable design of water and sewer installation. Present design exercises are being impeded by lack of design data for the conditions that exist in northern Saskatchewan.

A four year program has been set up to provide the necessary data on the thermal interactions between soil and pipe installations. The program is funded under a contract with the Department of Northern Saskatchewan, and was started late in 1974.

Temperature measuring systems have been set

up in the townsites of La Loche, Weyakwin, Buffalo Narrows and Cumberland House. Three of the sites were operational during the winter of 1974-75 and the results have been summarised up to May 1975 in a published interim report. A literature survey has been conducted in parallel with this work, to identify technical papers that are relevant to sanitary engineering practices in northern Saskatchewan. The findings have been summarized in a published bibliography.

Developing Methods for Evaluation of Ground Control in Potash Mines

Potash mines in the province are faced with the problem of how much potash to extract and how much to leave in place. If too much potash is extracted, the remaining pillars will provide inadequate support for the overburden. If too little is extracted, the mine is being operated wastefully and uneconomically. The staff of the various potash mines have to exercise judgement in designing their mining operations for the best balance of these two factors. Their task is made more difficult by a lack of information on the conditions that exist inside a typical potash pillar.

To remedy this situation the Council has initiated a program with two main aims; first to develop a cheap, accurate and reliable method for measuring stresses in a mine pillar; next, to demonstrate that the stress cells give a reliable and accurate indication of these stresses. This is a short program funded by the Department of Energy, Mines and Resources, and is being conducted in the Cominco mine at Vanscoy.

Two promising improvements of stress cells are being developed on prototypes. These will be tested against various other designs in a selected pillar in the Cominco mine. If the aims of the program are achieved, the potash industry will have, for the first time, a cheap diagnostic instrument with a demonstrated accuracy in measuring stresses.

Technical Assistance to the Ceramic Industry in Saskatchewan

In addition to undertaking its own program of practical studies in the ceramic and industrial mineral fields, the Council operates laboratory and pilot facilities for industrial companies. Staff of the ceramics laboratory are available for consultation and advice ranging from telephone conversations to detailed investigations.

In 1975 contract work was performed for Estevan Brick, Flin Flon Mines, and others.

A Process to Recover Magnesium Chloride from Saskatchewan Ores

Carnallite ore, an abundant magnesium mineral in Saskatchewan, can be mined from some existing potash mines in the province. The valuable constituent of the ore, magnesium chloride, is commercially processed in other countries to manufacture magnesium metal and alloys, and magnesia refractory materials.

A joint laboratory study with the Chemistry Division recently was conducted under contract with the Saskatchewan Department of Industry and Commerce and Saskatchewan Minerals to develop a process for separating pure magnesium chloride from raw carnallite ore. The results of the study show that this separation can be accomplished economically under Saskatchewan conditions with fertilizer grade potash obtained as a by-product. Future studies involving construction and operation of a pilot-scale process based on this work have been proposed for the coming year.

Stabilization of Bottom Sediments in Lakes and Reservoirs to Reduce Pollution

A large portion of nutrients such as phosphorus and nitrogen in a polluted body of water are absorbed into the solid sediments beneath the water. Under certain conditions, such as a deficiency of dissolved oxygen, these nutrients may be recycled back into the water and promote algal growths even though the source of pollution to the water has been eliminated.

A project sponsored by Environment Saskatchewan is underway to evaluate the effectiveness of flyash in sealing the floor of a lake or reservoir so that recycling of nutrients to the overlying water is prevented. A literature search and theoretical review of the recycling process is part of the project.

The initial experiments are being done on a small scale using sediment samples provided by Environment Saskatchewan. Should the results be encouraging, the experiments could be expanded to field studies at selected sites.

Favorable results from the overall program would assist in algae control, provide an outlet for flyash, and improve our knowledge of the nutrient recycling phenomenon.

Air Cushion Vehicles as a Means of Transportation in Saskatchewan For Special Purposes

Over the last four years the Council has been represented on the Associate Committee for Air Cushion Technology in Ottawa and has kept a close watch on the growth of air cushion technology, particularly with regard to its potential in Saskatchewan. Air cushion vehicles have now advanced to a stage where they could be of conceivable use in the province, particularly in the north, and it is clear that some government departments are recognizing their potential.

During the summer of 1975, the Council organised a field demonstration of the HJ-15 air cushion raft at Weyakwin. This was attended by almost 100 people from various government departments who, for the first time, were able to see an air cushion vehicle operating in a typical field situation. Arising from this, the Council is trying to establish in-province tests of an air cushion assisted logging transporter. If these tests are successful there would be several areas of transportation in the province that could benefit from this technology.

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REPORT OF THE GEOLOGY DIVISION

R. G. Arnold, Head

Evaluation of Lake Sediment Anomalies

During the summer of 1974 a Geological Survey of Canada - Department of Mineral Resources sponsored lake sediment sampling program was undertaken in northern Saskatchewan to "Delineate broad belts of increasing metal content, possibly correlative with features of economic interest". This survey involved the collection and analysis of center lake deep water oozes over 20,000 square miles of northern Saskatchewan at a density of one sample per 5 square miles.

The Geology Division undertook a follow-up of the above survey to evaluate indicated geochemical anomalies, to ascertain if the above objectives had been achieved and to determine if this type of survey is suitable for exploration purposes in northern Saskatchewan.

The field program involved the collection of outcrop, overburden, and lake sediment samples at selected anomaly sites. All samples were later analyzed for copper, zinc, nickel, lead, molybdenum, cobalt, uranium, iron, manganese, organic carbon and arsenic where appropriate. Thirty uranium anomalies, 21 copper and 9 arsenic anomalies were investigated.

Field observations indicate that uranium anomalies in lake sediments are due to uranium leached from pegmatites and granite gneiss terrain. Many of the anomalous samples are associated with broad regional trends. Copper anomalies evaluated were related to localized copper enrichment as well as broad units of specific rock type such as meta-amphibolite. All arsenic anomalies investigated were related to localized arsenopyrite mineralization.

This work was done under contract to the Department of Mineral Resources.

Exploration Geochemistry — Nemeiben Lake

The Geology Division, under contract with the Department of Mineral Resources, conducted a multi-media mineral exploration survey over a property located on the north shore of Nemeiben Lake, northern Saskatchewan. A total of 2,300 samples of outcrop, glacial erratics, overburden, lake sediments and muskeg were collected from a regular grid covering the area surveyed.

In order to define any mineralized zones, the collected samples were analyzed for copper, zinc, nickel, lead, molybdenum, uranium, cobalt, iron and manganese.

The report on the project will include:

1. listings of all sample descriptions, chemical analyses and pertinent statistics;
2. a physiographic map as an aid in interpreting element dispersion in the environment;
3. maps showing the distribution of copper and iron throughout the survey area;
4. a geology map of the area;
5. a geological interpretation of all data and an evaluation of the mineral potential of the property.

Applied Geochemistry as an Aid to Uranium Exploration

In view of the abundance of muskeg, lakes and glacially deposited overburden in northern Saskatchewan, geochemical surveys which involve sampling of bedrock and the surficial deposits will prove useful in uranium exploration.

A research-oriented, multi-media, geochemical survey involving the collection and analysis of samples of outcrop, float, overburden, lake waters, lake sediments and muskeg was conducted by the Geology Division at Duddridge Lake in northern Saskatchewan. This survey was undertaken with the co-operation of the companies holding the mineral disposition: Thor Exploration, Brascan Resources and Noranda Exploration. The property is characterized by uranium-bearing erratics.

The survey has documented the range of uranium values in various components of the surface environment, has provided a comparison between gamma-ray spectrometer and geochemical surveys, and a well-documented reference for future exploration surveys of this nature.

The results of the survey, including sample descriptions, analytical results and an interpretation of all data will be presented in a report and a journal publication in 1976.

Geology and Geochemistry of Saskatchewan Uranium Occurrences

This is a project initiated this year to study the geological setting, mineralogy, age, geochemistry of the new uranium occurrences in Saskatchewan. The program is designed to combine a thorough field study of the deposits with laboratory studies.

The objective of these studies is to gain an understanding of the genesis of the deposits so that geological and geochemical criteria can be developed for identifying favorable sites for uranium exploration.

As the project commenced after the close of the field season, the activities to date have involved literature studies and an examination of material previously collected from various Saskatchewan uranium occurrences. It is planned to initiate a full field program in 1976.

Environmental Geology

The purpose of this work is to compile accumulated information on the nature and distribution of glacial sediments in the settled area of Saskatchewan. The completed formation will have relevance for geotechnical investigations involving landslides, exploration for groundwater supplies, for sand and gravel resources, and for general environmental and land use studies.

The information will be published in the form of scientific papers and reports with maps and cross-sections.

This project will require several years to complete.

Meadow Lake and Fort Qu'Appelle Geologs

The objective of these projects is to compile booklets on the environment of Meadow Lake Provincial Park and the adjacent area and of the Fort Qu'Appelle area which can be used by the public to learn about the natural history of these areas.

The Meadow Lake environment is portrayed in a 107-mile road tour with 10 stops at which the environment is explained by means of descriptions, photographs, maps and sketches. The area around Fort Qu'Appelle will be shown by a 64-mile road tour of the Fishing Lakes area of the Qu'Appelle Valley.

The Meadow Lake Geolog has been completed, whereas only the field work for the Fort Qu'Appelle Geolog has been completed. These projects were carried out under contract to the Museum Branch, Department of Tourism and Renewable Resources.

Geological Framework for Mineral Search Using Glacial Deposits

This study involves the reconnaissance mapping and sampling of glacially derived sediments in the Precambrian of Saskatchewan up to 58 north latitude. The study is carried out using fixed-wing aircraft and boats. Power augering was done along access roads to determine the stratigraphy of glacial sediments and depth to bedrock. Sampling density for the mapping program in approximately one sample site per 40 square miles. Areas 73P, 74A, 64D, 63M and 63L (NTS designations) have been completed.

The objectives of the study are to determine the nature, distribution and origin of glacial and postglacial sediments that are required for mineral exploration in areas covered extensively with glaical sediments.

This year's program was the second of a four-year program carried out under contract to the Department of Mineral Resources as part of the DREE-funded geoscience programs.

Evaluation of Saskatchewan Groundwater Resources

The objective of the program is to obtain and interpret geologic, hydrologic and water quality data to make a quantitative assessment of the groundwater resources of Saskatchewan.

Groundwater levels were continued to be monitored in approximately 40 observation wells dispersed throughout the inhabited portion of the province. The information derived is basic to the management of groundwater resources and for the solution of a variety of groundwater problems. A rural water supply information service was continued to deal with requests for information.

Contract work engaged in during the year for Environment Saskatchewan included geohydrologic evaluation of the Moose Jaw effluent irrigation site and the hydrogeology of the Regina and Yorkton aquifers. Evaluation of salt migration through overburden into the Tessier aquifer was sponsored by the Salt Dust Committee.

Saskatchewan Lignite Resources Evaluation Program

The Saskatchewan Lignite Resources Evaluation Program undertaken in 1972 has three objectives:

1. to establish the geologic framework of the main coal bearing unit of the province (Ravenscrag Formation);
2. to delineate areas of significant coal occurrences;
3. within areas of coal occurrence, to determine the quantity and quality of the coal on a seam by seam basis.

The data base for the lignite program consists of geophysical logs, sample descriptions, and chemical analyses of coal samples obtained from

boreholes drilled during 1972 and 1973. Compilation of the data provides a preliminary estimate of lignite resources of 5.7 billion tons.

Compilation of the data for coal thickness, overburden thickness, coal structure, and coal quality for individual seams was continued this year in preparation for publication of maps and a report in 1976-77. This work has continued in conjunction with work by the Physics Division on automatic data processing of information obtained during the lignite program.

The computerized data base and final reports will provide the province with a physical framework for long term policy decisions on lignite utilization.

The program has joint federal-provincial funding as well as joint participation by the Saskatchewan Department of Mineral Resources, the Saskatchewan Research Council, Geological Survey of Canada, and the Energy Research Laboratories of the Department of Energy, Mines and Resources.

SPC Lignite Reserves Evaluation Program

The Lignite Reserves Evaluation Program undertaken for Saskatchewan Power Corporation in 1971 has three objectives:

1. to determine the mineable reserves of lignite on leases held by SPC;
2. to prepare detailed maps of seam thickness and structure, and overburden thickness and character for mine planning purposes;
3. to evaluate the data on a continuous basis in order to recommend modifications of the exploration strategy and to identify potential problems associated with the utilization of the lignite reserves that are identified.

During 1975-76, detailed drilling was undertaken in the area of the Coronach mine that will supply the Poplar River Power Plant and the mine area at Estevan that supplies the Boundary Dam Power Plant.

Coronach Mine Regional Groundwater Monitoring Program

Mining of lignite for the Poplar River Power Plant may have significant effects on groundwater levels in the Coronach region because of dewatering and drainage operations. In addition, the storage reservoir on the East Poplar River and groundwater production at the power plant will both affect groundwater levels in the area. In order to obtain baseline water level data and provide monitoring stations for long term measurement of water level fluctuations in the region, a regional monitoring program was undertaken for Saskatchewan Power Corporation in 1975-76.

At the end of 1975, 37 piezometers had been installed in which the water level can be measured. These regional monitors will provide the information that is necessary for designing detailed mine monitoring systems and for evaluating the effects of SPC operations on aquifers in the region. Additional monitoring requirements will be identified on the basis of data accumulated during 1975-76.

Researches in Economic Petrology: The Base Metal and Gold Potential of the Amisk Area

The economic re-evaluation of the Amisk-Neagle Lakes areas 25 miles west of Flin Flon, begun last year, is approaching its final phase. One hundred square miles of this ancient volcanic terrain has now been re-mapped and a number of economically promising localities have been found.

These favorable areas centre around small masses of rhyo-dacitic rocks, masses similar to those which host many base-metal occurrences elsewhere in Canada. Seven of the Amisk masses have been found by rigorous surface mapping while a few other sub-surface masses have been outlined by a quantitative pyroclastic mapping technique.

Both reconnaissance and detailed trace metal bedrock geochemical mapping has accompanied the lithological, structural and pyroclastic mapping. Bedrock geochemistry has indicated that two of the smaller rhyo-dacitic masses west of Amisk Lake are locally anomalous in copper, whereas, a third and partially submerged area within the large Missi Island body is anomalous in copper, zinc, arsenic and gold. Aeromagnetic data for five of the remaining masses suggest economic potential which may not be manifested in surface trace metal geochemistry.

In the final year of the Amisk project, geological coverage will be extended northwest towards the Hanson Lake road and eastwards towards Denare Beach and preparations will begin for the publication of a major report. It is anticipated that the techniques evolved and the data gained in this pilot project will be used in the economic evaluation of other ancient and geologically complex volcanic terrains in northern Saskatchewan.

Reports and Publications

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Haughton, D. R., *A Multi-Source Geochemical Survey of the Williams Peninsula Area*. SRC Report G 75-9 (Confidential).

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Haughton, D. R. and Shulist, M. J., *A Multi-Media Geochemical Survey of the Munroe Peninsula - Hives Lake Area*. SRC Report G 75-12 (Confidential).

Haughton, D. R. and Shulist, M. J., *A Multi-Media Geochemical Survey of Stewart Peninsula*. SRC Report G 75-13 (confidential).

Haughton, D. R. and Lehto, D. A. W., *A Multi-Media Geochemical Survey of the Nemeiben Lake (West Half) Property*. SRC Report G 75-14 (Confidential).

Haughton, D. R., *Geochemistry of Bedrock, Overburden Lake and Stream Sediments in the Stanley Area, (West Half), Saskatchewan*. SRC Report G 75-15.

McLean, J. R., *Evaluation of the Saskatchewan Power Corporation Lignite Exploration Permits and Leases*. SRC Report G 75-4 (Confidential).

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Whitaker, S. H., *Geology and Groundwater Resources of the Willow Bunch Lake Area*. Geology Division Map No. 20. SRC Report G 75-1.

Whitaker, S. H., *Geology and Groundwater Resources of the Weyburn Area*. Geology Division Map No. 21. SRC Report G 75-2.

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REPORT OF THE INDUSTRIAL SERVICES DIVISION

I. S. Evans, Head

The Technical Information Service

The technical information service provides free and confidential technical information to Saskatchewan's industry. A staff of engineers is available to provide professional assistance on the technical aspects of the province's industry. Utilizing contacts within the Saskatchewan Research Council and the sponsoring organization, the National Research Council, as well as professional contacts and personnel of technical institutes and universities throughout the country, the engineers can obtain expert advice and information on a wide range of engineering problems including plant engineering, materials selection, product standards, testing procedures, engineering design, equipment selection, properties of materials, and manufacturing processes. The technical training of the information officer enables him to assist in the analysis of problems and the indentification of critical technical aspects and permits him to assist in the interpretation and application of the pertinent information.

Clients of the service range across the broad spectrum of provincial industry including mining, forestry, agricultural, manufacturing, and construction companies located throughout the province. Over the year, hundreds of plant visits are made and the total inquiries answered number in the thousands.

The service has been invaluable to companies facing a major technical difficulty requiring a solution for the continuation of the company's activity. As an example, a hydraulic components manufacturer was having nearly 100 per cent failure of his product shipped to a second provincial manufacturer who was having problems due to the necessity of continuously replacing the component in machines sold and in service. A visit to the two companies, by an engineer from the Industrial Services Division resulted in a revised testing procedure by the component manufacturer to accurately simulate actual field conditions. The new test indicated a minor design change to solve both companies problems.

The broader benefit of the service is to provide a source of the best available technical information which Saskatchewan companies can apply to their general technical operations and overall decision making.

The level of utilization of the service indicates the value and necessity of its continued operation in making technical information available to industry. The financial and technical support of the National Research Council is gratefully acknowledged.

Publications

The Catalyst

- Quality Assurance
- On Dealing With Change
- Tomorrow's Managers
- Thoughts on the Future
- Quality Assurance
- Fuel Economy
- Research and Society
- Prescription For Recovery?
- Fuels and Their Conservation

Technical Service for Industry

Provincial industry can require technical assistance beyond that available under the technical information service which requires some extended involvement of the division in the company's operation or some specific technical investigation. Under this project, such technical assistance is available to the company on a fee-for-service basis.

Companies have used this service for assistance in engineering design, failure analysis, testing service, and product development.

This aspect of the division's effort is in the development stage and future operations will depend on the response received and additional client requirements.

Welding Improvement Program

The Canadian Welding Improvement Bureau and the National Research Council have continued their financial support for the employment of a welding specialist to improve welding and fabrication in Saskatchewan industry. The program is constituted of two parts: providing a technical expert to be available for consultation and advice and a general education effort.

Consultation has been provided to Saskatchewan industry on welding techniques, weld failures, and general metallurgical problems. Specific investigations undertaken include:

— brittle fracture of reinforcing bars;

— crankshaft weld fracture;
— weldability of steels in boiler manufacturing;
— machinability of gray cast irons;
— corrosion of welded steel and alloy tanks;
— ductility of hot rolled mild steel;
— pipeline welding techniques.

The financial benefit to the industries serviced with technical welding advice are not readily computed, but in many cases thousands and even tens of thousands of dollars are involved. More important than solving of specific problems, the general improvement in welding techniques provides the industry with a firmer technical basis for its operation, and better products for its customers.

To assist in the general improvement of welding in industry, four welding metallurgy courses have been conducted for welding foremen and supervisors. Thirty-five industry employees including engineers, technologists and foremen have completed the course. Industry has responded strongly to this course and additional sessions are planned for the future.

As well, course lectures on welding metallurgy and weld design have been given in the College of Engineering, University of Saskatchewan and at Kelsey Institute of Applied Arts and Science.

This program has provided many positive results in provincial industry and it is hoped that it may be established on a continuing basis.

Assistance in Obtaining Federal Research and Development Support

This program is based on the fact that considerable federal assistance is available for company-conducted research and development. However, the average small firm in Saskatchewan is not fully knowledgeable concerning each grant let alone the interrelationships of the multitude of grants and assistance programs available.

Of the many federal programs, those most applicable to the current Saskatchewan situation are:

—The National Research Council's Industrial Assistance Program.

—The Department of Industry, Trade and Commerce's Program for the Advancement of Industrial Technology, the Agricultural Market Assistance Program, and the Industrial Research and Development Incentives Act;

—The Department of Regional Economic Expansion (DREE) grants.

During 1975, the Division has assisted companies obtain a total in excess of $700,000 to support their own research and development. One other application is being processed which, if approved, would bring the total well over $1 million.

The Division operates on the basis of providing advice and assistance to Saskatchewan firms on a free basis and under contract when requested to complete an application and carry out the necessary negotiations.

Work on the grant applications has indicated a need for market and feasibility studies necessary to justify research and development expenditures. This Division has undertaken several feasibility studies for industry and market studies for two government departments.

This project will be contined in 1976 with expansion in the marketing and feasibility studies area.

Saskatchewan Information Retrieval Centre

The capability of on line information retrieval is not generally available in the province. As a pilot project, the needs of the province as a whole, and the industrial sector particularly, will be examined to determine the value of establishing a central service available to provide information services on a cost recovery basis.

An effect of this project may be an acceleration of the adoption of on line information retrieval by organizations to provide service to themselves. This is a desirable end in itself and would be to the benefit of the province.

Saskatchewan must, as in many things, pay a penalty for its geographic location, but even with this cost disadvantage, on line information retrieval appears to offer an economic advantage over traditional literature searching techniques. Within the limitations of those data bases available for on line searching, the quality of information retrieval can equal that available anywhere.

This program is essentially an evaluative one, which will require at least an additional year before the best future direction can be determined.

Saskatchewan Research Council Library

The Library serves essentially as an output node of an informal Canadian information network. Its function is to provide its clientele with available information on specific topics.

The initial step is to determine what pertinent information is available; secondly, the information containing documents must be obtained.

Union Lists and Union Catalogs play an esential role in determining the availability of certain materials from the library network. As well, direct contacts with publishers and information producers including universities, government departments, and corporations provides effective document acquisition services. Essential back up depositories such as the Canadian Institute for Scientific and Technical Information with its extensive holdings in

the fields of science and technology makes nearly all published information available to our clients.

The continuing information explosions has made the determination of what pertinent information is available the more difficult aspect of servicing our clients needs. Traditionally, abstract journals and indexes were manually searched for pertinent information. Limitations of available sources and the labour cost of extensive searching were real deterrents to effective information retrieval.

The advent of on line computer searching of the bibliographic records from abstract journals reduces the labour imput of literature searching to a minimum and greatly expands the ability of the library to provide customized search services. The library accesses through a computer terminal over 30 data bases maintained on computers by a number of agencies. Over five million references are available for on line computer searching.

While on line computer searching can not be a panacea, it is a quantum step of progress in making information retrieval fast, efficient and economic.

Industrial Engineering

During the year, the division's industrial engineering program continued to provide assistance to Saskatchewan industry. Companies served during this period ranged from small town implement manufacturing companies to city newspapers.

The Council's industrial engineers demonstrated to one producer of advertising flyers that the company's losses could be turned to profits by *reducing* the number of advertisements and increasing their size. On another occasion, an analysis showed that a proposed automated manufacturing machine was not required and that other steps would be more desirable in improving the profitability of a company manufacturing mining parts.

The production of one food product company was increased substantially by modifying the processing which had been the bottleneck. On another occasion, the industrial engineers were able to eliminate the necessity for significant capital expenditures on the killing floor of a packing plant.

In September, a senior management seminar for Saskatchewan presidents and general managers was sponsored. This seminar featured Mitchell Fein, a leading American industrial engineer who specializes in the area of motivation and incentives. Approximately 70 participants attended. As a result of this seminar, several clients are developing programs within their firms which will result in increased compensation to their employees.

The Division's industrial engineers are also responsible for the Council's publication, *Industrial Business Management*, which is received regularly by about 3,000 managers in the province and throughout the world. Topics discussed during the last year were:

Pointers On Scheduling Production;
How Success Can Ruin A New Business;
A Doctrine Of Business Management;
How to Set Up A Maintenance System;
Profits Through Management Upgrading & Recruitment;
Planning For Managers;
Basic Budgets For Profit Planning;
The Organization Matrix;
Accounting For Inventory Profit;
Strategy & Flexibility In The Smaller Business;
Piecework In Industry;
Charlie's Rod-Jigger & The Ideals Concept For Better Design.

The industrial engineering program also develops specialized pamphlets and materials on subjects relevant to industrial management. Material is available on such topics as plant layout, salesmanship, time management, budgeting, and product design.

REPORT OF THE PHYSICS DIVISION

J. Maybank, Head

Climatology

Climatic studies in respect to the enviromental impact of industrial development were in increased demand this past year. Clients in both primary and secondary industry, located in both northern and southern Saskatchewan, sought SRC assistance during 1975.

The positive aspects of climate with respect to energy production were also investigated. A major, broad-scale study of wind power potential was carried out on behalf of the Saskatchewan Power Corporation. A preliminary investigation of solar power potential has begun.

Agricultural climatology continued as a major component in the program. Further joint investigation of field plots were carried out with the co-operation of the Crop Science Department of the University of Saskatchewan. Data correlating crop development and yield with weather factors are undergoing evaluation. Resource data on agroclimatology was prepared for the Department of Continuing Education, Wascana Institute, in support of their 10-week farm short course program.

Use of metric units in weather reporting has necessitated the updating of several million records held in the SRC Climatological Data Bank. This process is being implemented gradually, with consequent delays in publication of results.

Climatological Reference Station

The outdoor test bench facilities provided at the climatological reference station served both SRC users and others during 1975. Several university departments made short-term use of CRS, while long-term support was provided for a Canada Agriculture project concerned with weather sensitivity of grasshopper eggs and a Western Canada College of Veterinary Medicine study of roundworm dissemination.

The specialized program of benchmark measurements was continued, maintaining, for instance, a continuous series of solar radiation measurements at Saskatoon since 1953. This is the only long-term record of this nature in the province. Air temperature gradient measurement, of interest in relation to air pollution and energy balance studies, was added during 1975. Data acquisition facilities were also upgraded.

The station contined to produce monthly and annual summaries, serving 42 institutional and 25 individual clients on a regular basis. Reference station operations are supported, in part, through a contract with the Atmospheric Environment Service.

Precipitation Physics

Instrumentation was designed and put into operation at the climatological reference station this year to study the changes in the earth's surface electric field during blowing and drifting snow conditions.

Increases in the normal field regime, of an order of magnitude, were recorded. This was found to correlate well with a number of environmental parameters, the most important of which were wind speed and air temperature.

Since the phenomenon is one of ice crystal — ice crystal collision, it may be possible to monitor various environmental regimes by this technique. As the crystals blow over a snow pack and interact with it, the charge separation and hence the strength (and direction) of the electric field is a function of air-snow temperature and saturation differences. It may be possible to assess the state of the snow pack for the province; for instance, whether it is growing or diminishing by sublimation. It is also felt that there may be some unique features of atmospheric electricity that may take effect prior to the snow pack melting.

Air Pollution Studies

Industrial smoke plumes emit not only particulate aerosols into the environment, but also significant amounts of space charge as well. Research is currently underway to assess the feasibility of utilizing this space charge to study the dispersion of dust plumes into the environment.

Preliminary work was undertaken this year to apply this technique to the dust plumes of the potash industry. It is concluded that the effluent is highly charged and that the technique can be used to trace potash dust 5 km or more from the mine site.

A continuing program, using this electrostatic plume tracing technique, is being undertaken to assess the dispersive power of the atmosphere for potash dust under a wide variety of meteorological

and atmospheric stability regimes. The technique is found to work best precisely when air pollution hazards are at an extreme that is during stable inversions. At this time the background atmospheric electricity is the most stable.

Pesticide Spray Drift Studies

The herbicide spray drift trials continued this year with the largest number of field trials successfully completed in any year since the project's inception. This work was supported by a research contract with Canada Agriculture, at a considerably higher level of funding than had been possible in the past.

A significant innovation this year was the introduction of a double boom ground-rig system. By means of this arrangement it is possible to expose the two separate spray booms to the same meteorological turbulence conditions. In order to allow independent tracing of the spray, emitted from each boom, a different fluorescent dye was used in each case. In addition, several new nozzle designs, and solution additives were tested, with the result that drifting fractions as monitored by a sampling system 5 meters from the swath were down to a respectable 1 per cent or less.

Often, however, it was seen that by improving the drift characteristics of a given system one obtained a complementary degradation of the on-swath parameters. Swath deposit variability and volume, median, and diameter of droplets increase dramatically as drift is decreased.

The drift potential of a new spraying system of the Spra-Coupe was assessed. It was found that herbicide drift was increased to 4 or 5 per cent, but the much increased speed of the spray may make this unit an economically viable system.

New attempts were made to bracket the cloud in the vertical by extending sampling to 5 meters. With the ground-rig trials this proved to be a significant aid in physical analysis. However, with the aircraft trials, it only served to emphasize the tremendous height of the driftable droplet cloud (well above 5 meters under light winds).

A new jumpcard technique was developed in sampling water-base sprays for their size distribution. A photographic paper coated with a mixture of bromophenol blue indicator and acetone in toluene was produced by wetting clear blue stains, with known spread factor, and often staining top-coated for permanent storage. This paper was used in the entire field trials of ground spray operation with success.

From 300 nozzles, the orifice wear, the discharge rate, and the discharge uniformity were investigated. The result shows that more careful maintenance and operation of spray equipment is required to reduce the drift hazard from spraying of herbicide.

The performance of a newly developed spray formulation and nozzle was examined by field trials of serial spray application under a commercial contract. The use of the new formulation suppressed the evaporation of spray droplets while the new nozzle disseminated spray with less drift potential. The use of these new techniques with minor modification was recommended for crop spraying by aircraft.

Atmospheric Grain Dust Studies

Dustfall sampling continued during 1974 (fall) - 1975 (spring) season and a background station away from any dust-emission source at 2 miles south of Aberdeen was added to the sampling jar network. The level of background (total mass) reached its minimum during January-February when the ground was totally snow covered. The ratio of net dustfall to the background was of the order of 2 for the entire sampling period. The result of analysis of composition and dustfall density confirmed the result obtained for the previous sampling. During snowfall periods dustfall samples were collected by a special wet surface technique and counted by using a flow-ultramicroscope technique. The ratio of hourly particle by number was 30 per cent near the elevator and 5 per cent at outer circle of sampling network. The use of a fiber diameter resistance-shape factor was proposed in settling of organic dust in the gravitational field. Verification of a model for irregular dust particles was attempted by solving an equation of motion numerically, and also by observing the trajectory of settling using a time-lapse cinematography, and by investigating the shape of dust with a scanning electron microscope.

To complement the analysis of dustfall sampling in Aberdeen, a dustfall model has been employed to determine the average area dosage in $mg/m^2/month$. The model accounts for the amount of deposit material by incorporating the free fall speeds of dust fractions, the wind direction climatology and air mass stability into an empirical equation. Results from the model are quite encouraging. It is hoped that the environmental grain dust hazard might be assessed not only for different towns but also for different seasons of the year.

Lignite Resource Data Analyses

The joint federal-provincial lignite coal resources evaluation program began in 1971 and reached the compilation stage in 1974. The main purpose to date of the Physics Division's part of the program is to process the results and build a computer processable file of the chemical analysis of coal samples obtained from approximately 500 sites. The co-operative program designed to obtain and correlate analytical, geophysical and geological data involves the Canada Department of Energy, Mines and Resources, the Saskatchewan Department of Mineral Resources and the Saskatchewan Research Council.

The processing of the analytical data is continuing to be undertaken in co-operation with Dr. T. E. Tibbetts, head of coal and peat resources evaluation, Department of Energy, Mines and Resources. The co-ordination of site location and sample interval data is continuing to be undertaken with Dr. S. H. Whitaker, Geology Division, (SRC). The present status of the coal chemistry file is that analytic information concerning 4,124 samples from 432 drillhole sites in Saskatchewan is reported on computer tape. Analytic data concerning information from another 96 sites is not yet reported on the coal chemistry file; this collection of data gathered since the beginning of the program, requires additional and non-routine processing. Effort is now underway to bring the file up-to-date and to perform final verification of data currently reported on the file.

A large effort is directed toward creating a certified data-base residing on magnetic tape. The computer-assisted procedures for maintaining the file are completed and are functioning on a routine basis. Computer processing of information is rapid and efficient. The greatest amount of time is spent preparing and checking data items that now number about 35,000 analytic and about 17,000 location and sample interval data-items.

Several specific computer programs at the SRC are used to help test and check information on the coal chemistry file. Work of preparing computer programs to help study data on the coal chemistry file is continuing.

Data processing work, to construct a file of borehole geophysical information for the above program is underway. The main emphasis is on building a file of information concerning borehole geophysical measurements recorded during the field work portion of the coal resources program. The main geophysical information includes the density, gamma ray and caliper measurements recorded at each site. The objective is to digitize the recorded curve-traces and to report the digitized data on magnetic tape. The purpose of the file of digitized geophysical information is to help correlate the chemical with the geological information at each site and thereby assist the coal resources inventory.

Equipment for digitizing graphical information and for translating perforated paper tape (from the digitizer) onto magnetic tape was built and is operating at the SRC. Computer programs used to process data obtained through the digitizer/translator units are available and operating at this time Council reports on the use of this equipment are nearing completion. Work is started on digitizing geophysical logs from sites where samples for chemical analysis were obtained by the "reverse-circulation" method.

In May, a paper was given at the 77th annual general meeting of the Canadian Institute of Mining and Metallurgy (Toronto) on the electronic data processing aspect of the Saskatchewan lignite resources evaluation program.

Groundwater Geophysics

The main objective of this program is to engage in applied studies to contribute to the technology of water well development. The main project in this area is the study of performance characteristics of large-diameter water wells. One aspect of this has involved the testing of a large-diameter sand filter (Etcheverry and Hendren, 1975) in co-operation with the Department of Mechanical Engineering and the Department of Agricultural Engineering, University of Saskatchewan.

In shallow, large-diameter Saskatchewan farm water wells, there is often a problem of silt and sand from the aquifer entering the well. This may cause a progressive decrease in water production and increased wear to pumps with the eventual total failure of the water well. A proposed solution is to install a "gravel pack" at the bottom of the well. The filter, mentioned above, was built by Variperm Canada Ltd. (Swift Current) on a prototype basis with the intention that tests would be conducted to determine the headloss and silt retention of the filter. Headloss tests were carried out but so far field trials have not been undertaken.

A second project in the groundwater area involves the measurement of temperatures in the ground at one site to a depth of about 524 feet. A report on the use and performance of an instrument called the multiple program sequenced recording system (MPSRS) is completed. A report which discusses the results of geothermal measurements is not completed at this time.

Again this year, several requests have been received from farmers concerning the use of the Council's clamshell dredge which was designed several years ago. This equipment has been successfully rented for a nominal fee to individuals requesting use of it.

Earlier this year, lectures were given at the Southern Alberta Institute of Technology (Calgary) and at the Northern Alberta Institute of Technology (Edmonton) on behalf of a water well driller's school sponsored by SAIT. The subject of the lecture concerned the interpretation of electric log information as applied to groundwater technology. A total of 50 persons attended the school.

Information Management Systems

The main emphasis in the area of geophysics has involved investigations and use of computer-assisted methods of handling, storage, retrieval and analysis of large bodies of data. Data handling projects have accounted for about eighty percent (as compared to about 50 per cent last year) of the geophysical activities this year.

The major emphasis, as mentioned, has been in the area of lignite coal resources information handling. In addition to processing analytic and geophysical information, work to compile a cross-referenced index to "Saskatchewan Lignite Literature" (Pilon, 1975) is nearing completion. For this work, citations are coded and entered into a commercially available computer-assisted retrieval system called FAMULUS. The objectives of this work were: to build a resource library on the subject of Saskatchewan lignite using established public and specialized libraries and commercial data bases; to compile bibliographics and indexes; and to employ FAMULUS programs to retrieve information when necessary using specified search formulae.

All computer procedures are run on computer facilities at the Saskatoon Regional Computing Centre using equipment owned and operated by the Saskatchewan Computer Utility Corporation, SASKCOMP. Large scale jobs are run on an IBM 370/158 computer using programs written in ANSI COBOL and FORTRAN. For smaller jobs, use is made of a Hewlett-Packard 2000F computer with programs written in timeshared BASIC; access to this computer is by telephone line from a small terminal.

Some work is continuing, as funds permit, on building a computer processable file of hydraulic-head information; this is work undertaken in cooperation with Dr. W. A. Meneley, Geology Division (SRC). The purpose of this applied work is to provide a data base which will contribute to the technology of water well development, increase the chance of finding aquifers and to aid in making information on groundwater more available.

This work entails the use of digitizer and tape translator equipment mentioned earlier and the applications of computer programs which are similar to those used in processing geophysical data.

Cold Weather Technology

Cold weather has a profound influence on the economy and life style of the province. As a preliminary to more detailed investigation, the following aspects of the cold weather problem are under investigation:

— extremes of cold,
— persistence of cold spells,
— weather patterns associated with cold spells,
— trends in temperature over time.

Publication of preliminary results from some of this work is expected during 1976.

Remote Sensing

A remote sensing activity was maintained during 1975. Data was collected concerning the spectral reflectance of a few cereal crop varieties and clear sky irradiance at Saskatoon. Airborne imagery was partially assessed for its potential in soil moisture estimation. Preliminary work on the use of satellite imagery for mapping Saskatchewan forest fires was begun. Imagery from the NOAA-2 satellite was collected for evaluation of its potential as a monitoring tool.

Electronics Laboratory

In addition to providing specialized support for the Council's research program, the electronics laboratory expanded its operation to provide extensive contractual service to a number of outside agencies in government, university and industry. This service included consultation, design, fabrication and maintenance pertaining to electronic instruments and systems. It is the intention of the laboratory to continue, and further expand if necessary, this much needed service in the province.

In 1975 the electronics laboratory provided service to the following agencies: Saskatchewan Power Corporation, Saskatchewan Highways and Transportation Department, Saskatchewan Department of Tourism and Renewable Resources, CORE Services, Agriculture Canada, Intercontinental Packers, Smith-Roles Ltd., Saskatchewan Institute of Pedology, and the College of Medicine, University of Saskatchewan.

Some of the instruments designed and, or, constructed for these outside agencies included an electronic fisher, a sequence timer for a bird scaring cannon and a hog-stunner. This diverse list indicates the flexibility of the laboratory in handling a wide range of requests.

A major project in 1975 was the development of a network simulator under contract with the Saskatchewan Power Corporation. This project was a cooperative endeavour with Dr. Jan Carr of S.P.C. Preliminary work on a prototype had been completed in 1974. The network simulator is a bench model comprised of several electronic "black boxes" which will allow engineers to simulate a network consisting of: 3-phase generators, 3-phase current transformers, circuit breakers, and up to 1,000 miles of high voltage 3-phase lines. In addition provision is made to introduce controlled faults into the simulator either under manual or computer control. At this time prototypes of all modules have been designed, constructed and tested. Final units are now in the construction stage.

A fairly extensive project for the internal use of the Council was the design and construction of a paper/magnetic tape data translator. This device translates data from standard perforated paper tape to computer compatible magnetic tape. This allows data to be acquired on a cheap, reliable, easily edited, flexible medium, i.e. paper tape, and then to be transcribed, under program control to a more

appropriate medium for data storage and input to a computer, i.e. magnetic tape.

The electronics laboratory continues to up-date its own facilities and maintain expertise in a fast moving technology. A secondary time/frequency standard, with an inaccuracy of less than one part per billion, was designed and constructed to add to the laboratory's calibration capabilities. Also this year a microcomputer set was purchased and assembled. This has given staff some "hands on" experience with microcomputers, also called "Microprocessors". This experience will aid in the design of future systems using microprocessors as control elements.

A current limiting power supply for electrolysis, designed and constructed for the Chemistry Division's carbon dating laboratory, completes the list of instruments developed by the electronics laboratory.

In the 17 years the electronics laboratory has been established a comprehensive stock of electronic components has been acquired. This year a catalog of these components was compiled. While this catalog is primarily intended for use by Council staff, it is also available to outside organizations to be used in emergency situations where long delivery times from normal suppliers are anticipated.

Finally, the laboratory has participated in preliminary discussions held by the federal Department of Industry, Trade and Commerce regarding the establishment of a national instrument evaluation service. The electronics laboratory has indicated a willingness to provide, on a contract basis, some portion of any required evaluation service.

Precision Instruments Facility

The water level recorder with the special actuator device (Hoimeaga) that had been designed at the Council proved to be of considerable interest to other agencies desirous of obtaining records at remote well-head sites. While much of the first half of the year was devoted to completing an order for 20 of these units for Geology Division, a further six were fabricated to fill purchase orders for them from two organizations in Alberta.

A modified and improved version of the gas volugraph instrument was constructed for potential use by the uranium mining industry. It provides a rapid recording system for carbonate analysis of rock samples.

Several microscope projection units were constructed for the Department of Northern Saskatchewan. These were designed to fit on equipment already owned by them, and facilitated their more versatile operation.

A special cold chamber was purchased early in the year, and adapted to operate under very carefully controlled conditions. It is for use in instrument testing and calibration. The effects of extreme weather conditions on sensitive equipment can be identified prior to their operational use and suitable modifications incorporated where necessary.

Instrumentation Graphics

The purpose of this project is to complete and formalize the description and the specifications of equipment designed and built at the SRC. This work is in aid of other programs dependent on the equipment, and helps investigate the potential marketability of this equipment. Some instruments are used regularly and therefore require "user" and "maintenance" documentation. Other devices have more general applications and require "technical" and "specifications" documentation. Through this project, documentation in the form of technical drawings, photographs and reports are produced. Special emphasis has been placed on standardization of the documentation procedures and products.

This year, documentation of a data acquisition system called the multichannel programme sequenced recording system (MPSRS) was completed with publication of a SRC report. Technical plans were also completed for a Stepping Motor and Controller, two components of the SRC designed water level recorder system. Patent investigation proceedings have been instigated with regard to these two components. Reports on the data tablet digitizer system and the data translator system, two instruments designed to aid in assorted data processing applications, are nearing completion. These reports will describe the general system and operating procedures. Detailed technical reports will be prepared later.

Reports and Publications

Barnett, D. B., *SRC Catalog of Electronic Components*. SRC Report P 75-1.

Barnett, D. B., *Instruction Manual for MPSRS: Multichannel Program Sequenced Recording System*. SRC Report P 75-9.

Bergsteinsson, J. L., *A Regional Climatology of Saskatchewan for Wind Power*. SRC Report P 75-11 (Confidential).

Bergsteinsson, J. L., Ross, W. H., and Austenson, H. M., *A Weather-Related Regression Model to Determine Wheat Yields at Saskatoon, Sask*. Proceedings of the Western Canada Soil Fertility Workshop, 1975.

Dyck, J. H., *Downie Slide, B.C. — Preliminary Report: Review of Downhole Logging Procedures*. SRC Report P 74-10 (Confidential).

Dyck, J. H., *Downie Slide, B.C. — Review of Calibration and Repeatability Trials for Geophysical Logs, November 1974*. SRC Report P 75-10 (Confidential).

Etcheverry, R. V. and Hendren, K. W., *A Study of Head Loss Characteristics of a Large Diameter Sand Filter* SRC Report P 75-7.

Maybank, J., Yoshida, K., and Shewchuk, S. R., *Investigation of Airborne Grain Dust Emanating from a Prairie Grain Elevator and Its Subsequent Drift and Deposition Pattern. Phase II.* SRC Report P 75-4.

Morrison, B., *Naturally Induced Polarization and Water Potential Anomalies.* SRC Report P 75-2.

Pilon, C. A., *Saskatchewan Lignite Literature.* SRC Report P 75-6.

Pilon, C. A., *Saskatchewan Lignite Literature: A Cross-Referencing Index Using the FAMULUS Computer Programs.* SRC Report P 75-13.

Shewchuk, S. R., *A Preliminary Report on the Electrostatic Technique of Plume Tracing.* SRC Report P 75-5.

Yoshida, K. and Shewchuk, S. R., *Determination of Discharge Rates and Particle Size Distributions of Dust From Potash Drier Systems, Report No. 3.* SRC Report P 75-3 (Confidential).

Yoshida, K. and Wallace, K., *Spread Factor of 2,4-D Dimethylamine Solution Droplets on Indicator-Coated Photoemulsion Surface.* SRC Report P 75-8.

Yoshida, K. and Shewchuk, S. R., *Drift Measurements of Aerially Applied 2,4-D Spray (CGH-3820 Formulation) From Raindrop Nozzles.* SRC Report P 75-12 (Confidential).

THE UNIVERSITY PROGRAM

SCHOLARSHIPS

The Government of the Province of Saskatchewan offers graduate research scholarships tenable at either the University of Saskatchewan or the University of Regina. The purposes of the awards are to assist graduate students to prepare for careers in scientific and industrial research and to create interest in the exploitation of Saskatchewan's resources and in techniques that will advance the development of the Province. The Council conducts the selection of the awards.

Awards valued at $5,000 for the year beginning October 1, 1975 were made to:

H. J. Anderson, Plant Ecology, University of Saskatchewan

J. W. Rowson, Chemistry, University of Regina

L. F. Kratt, Biology, University of Saskatchewan

GRANTS-IN-AID

Since its creation in 1947, the Saskatchewan Research Council has provided grants to University of Saskatchewan applicants for applied research in the sciences. Fifteen grants totalling approximately $75,000 were awarded in 1975 to applicants at both the University of Saskatchewan and the University of Regina. This excludes grants totalling approximately $45,000 from the Saskatchewan Mining Association and Environment Saskatchewan towards the study entitled Distribution and Fate of Potassium Chloride Dustfall in the Environment undertaken by staff of the Department of Soil Science, University of Saskatchewan and the Saskatchewan Research Council.

It should be noted that since the following reports are prepared approximately half way through the grant year specific results are usually not available for reporting. Copies of all papers published in the literature and of all theses resulting from grants-in-aid support by the Saskatchewan Research Council are available at the Saskatchewan Research Council library.

UNIVERSITY OF REGINA

DEPARTMENT OF BIOLOGY

Studies on Iron Bacteria

under the direction of
Professor R. D. Cullimore

A considerable amount of knowledge has been accumulated on the factors influencing the growth and occurrence of the "nuisance" iron bacteria which infest many wells and water supply systems at an annual cost to the province estimated at between four and six million dollars. Studies in progress indicate the following factors to be critical to the growth of these bacteria: manganese and iron concentrations and the ratio of these elements, organic carbon, rate of flow, temperature, pH and oxygen concentration. Iron bacteria studied extensively in the laboratory have exhibited a greater dependence on manganese in the water than iron. This would indicate that investigations of well water should also include manganese as an essential parameter. Field studies using new techniques developed within this project have revealed that iron bacteria are endemic (ubiquitous) in groundwaters throughout the southern part of Saskatchewan although frequently occuring in very low numbers. Control studies conducted have revealed the bacteria to be very resistant to most chemical agents (F.F.I.B. study) but a survey of the bacterias sensitivity to heat showed them to be very sensitive. Initial application of techniques based on this weakness have been successfully conducted and well flow rates have increased up to threefold their previous levels. A complete report of this study will be presented at the symposium on "Aquatic Microbiology" to be held at Lancaster, U.K. by the Society of Applied Bacteriology and subsequently to be published as a chapter in the Symposium volume.

The author wishes to express gratitude to the following people for help in the project: Mrs. A. E. McCann, Miss J. Anweiler, Mr. M. Riley and R. S. Yang; and also to Dr. Meneley as co-ordinator of the project for this helpful advice; and finally to the Family Farm Improvement Branch, Saskatchewan Department of Agriculture for funding studies into the direct control of iron bacteria thus speeding up application of the knowledge gained in this project.

DEPARTMENT OF CHEMISTRY

Analytical and Physico-Chemical Studies on Herbicides

under the direction of
Professor F. H. A. Rummens

In the report year three publications appeared in print, based on our SRC-supported work on pesticides.

— F. H. A. Rummens; *An Improved Definition of Synergistic and Antagonistic Effects*. Weed Science *23*, 4-6 (1975).

— F. H. A. Rummens; *Separation and Structural Assignment of the Cis and Trans isomers of Diallate*. Weed Science *23*, 7-10 (1975).

— F. H. A. Rummens, D.C.M. Rummens-Ditters, A. E. Smith; *The Effects of Diallate and its Isomers on the Growth of Wild Oats*. Weed Science *23*, 11-14 (1975).

Paper (2) and (3) deal with the wild-oat herbicide diallate, which is widely used in Saskatchewan. The commercial diallate has turned out to be a mixture of two isomers, who indeed both have good anti-wild oats activity, but the activity of the mixture is much reduced by a strong antagonistic effect which has been shown to exist if the two isomers are applied simultaneously as in the commercial diallate.

Paper (1) is potentially of much greater importance because it deals quantitatively with all types of synergisms, whether in mixtures of herbicides, pesticides, fertilizer or even in medication drugs or dangerous drugs. This paper has drawn considerable world-wide attention already.

Our attempts to find analytical techniques for the assay of the pesticides MCPA, MCPB, MCPP and other mono-chloro phenoxy derivatives have now gone into their 4th year. At long last success now appears in the offing. The technique being perfected consists or reacting the phenoxy acids with $C_6F_5CH_2Br$, followed by electron-capture gas chromatographic detection of the ester so formed. The macro scale synthesis of these esters has been completed (yields above 95 per cent). Calibration has shown that detection limits of well below 10

ppb are available in principle. A clean-up procedure (of plants extracts) has been developed which leaves the C_nF_5-CH_2 esters intact with complete recovery. Present experiments are dealing with micro scale *in-vitro* synthesis with amounts MCPA/B/P as are to be expected in real samples such as plant extracts. At present, some difficulties of unknown origin are encountered in this stage, resulting in fluctuating yields. It is hoped that in the next 6 months this problem can be resolved.

Since September 1, 1975 Miss R. Bujaczek is working fulltime on this problem, following the summer work (May - August 1975) of Mr. Ch. Wong. This research is done in cooperation with Dr. A. Cessna, Agriculture Canada, Regina Research Station.

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CHEMISTRY AND CHEMICAL ENGINEERING

Utilization of Fly Ash

under the direction of
Professor N. N. Bakhshi

In Saskatchewan, as in other parts of Canada and the United States, large quantities of fly ash are being generated and stockpiled by the thermoelectric power generating facilities. Chemical analysis shows that fly ash contains many useful elements such as aluminum, iron, and calcium and hence might prove to be useful in other sectors of the economy.

A unique process has been developed at the University of Saskatchewan by N. N. Bakhshi and D. G. Macdonald, with graduate students R. G. Gillies, and M. S. Naser, under the financial assistance of the SRC to utilize the fly ash in the removal of brown color from kraft pulp mill effluents. Initially, fly ash was added directly to the bleach plant caustic extraction effluent (where the majority of the color originates) but 1000 g/l would only reduce the color by 51 per cent. However, treatment of the fly ash with acid (HCl) was found to release the aluminum, iron and calcium from the fly ash as chlorides and these effectively removed the color from the effluent. The amount of acid needed was 20 meq of HCl/g fly ash and only 1.9 g of acidified fly ash was required to remove 98 per cent of the color from 1 litre of effluent with a color of 12,000 APHA units (88 per cent removal of the chemical oxygen demand [COD]) at an optimum pH of 5.0. It has been estimated that one million gallons of the effluent would require 8 tons of fly ash, 5.8 tons of HCl, and produce 20 tons of dried sludge.

A cost study has not been done but it appears that the capital costs would be similar to other color removal processes and the main operating costs would be the shipping costs of the fly ash and the cost of the HCl. The cost of the HCl can be eliminated by using the chlorine bleaching stage effluent which contains sufficient HCl to acidify the fly ash. This aspect is now under study by Mr. N. Rao, a graduate student. Future work would involve a pilot plant study to obtain sufficient operating data to determine the economic feasibility of the process.

Production of Sugar and Protein From Aspen Fibre and Chips

under the direction of
Professor D. G. Macdonald

Saskatchewan has a large quanitity of Aspen Poplar which is not being utilized. Drs. Mathews and Pepper of this department have shown that simple steam treatment will make Aspen chips a good source of feed for sheep and cattle. Other workers elsewhere have shown that waste cellulose can be converted to sugar or protein using microorganisms. If Aspen Poplar could be economically converted directly to sugar or protein, this would be an added benefit for Saskatchewan.

A literature survey and some preliminary experimental research have been carried out by Mr. Peter Dessens, a student assistant, under the supervision of Dr. D. G. Macdonald and in liaison with Mr. J. A. Kernan and Dr. E. M. Coxworth of SRC. Two microorganisms, *Trichoderma viride* and *Aspergillus niger*, were chosen and grown on steam treated Aspen fibre in both shake flasks and in a 14-L fermentor. Growth was observed but most of the research efforts were in testing analytical procedures for measuring protein production, growth rates, and cellulose utilization. Samples were analyzed for protein in the feed testing laboratories on campus and use was also made of the Departmental Analytical Laboratory of Mr. E. C. Bailey.

Growth of the above organisms will be carried out on both treated and steam treated Aspen to determine the extent by which the growth rates are increased by steam treatment. Rates of hydrolysis and percent conversion of the Aspen will then be measured to determine if this method is feasible and further investigations are warranted.

DEPARTMENT OF CIVIL ENGINEERING

Design Considerations for Swelling Clays

under the direction of
Professor D. G. Fredlund

The province of Saskatchewan has considerable surface area which has lacustrine deposits at the surface (eg. Regina, Tisdale, Eston, Saskatoon, etc.). As a result of the semi-arid climate throughout most of Saskatchewan, these deposits have become highly dessicated and dried. Construction

on these deposits generally result in distress to the engineering structure due to a swelling of the underlying soil.

The object of our research program is to establish reliable design procedures that can be applied to the behavior of swelling clays. Three main areas of research are presently underway:

1. The development of analytical procedures for the prediction of heave below light structures. The theoretical context has been developed and the program is now concentrating on case histories to compare predicted and measured amounts of heave. The cases under consideration range from measured heaves below lightly loaded structures to the ridging of flexible pavements.

2. A common occurrence in cuts or fills in swelling clays is their reduction in strength with time. Several cases of slope instability have been monitored. An attempt is being made to make the prediction of instability amenable to analytical solution.

3. At present, it is not possible to monitor *in situ* tensions in the water phase over a wide range of stresses. Work is underway on the development of a device that will allow the *in situ* measurement of water tensions over a long period of time.

Publications

D. G. Fredlund. *Engineering Properties of Expansive Clays*. Presented to the Seminar on Shallow Foundations on Expansive Clays, Regina, October 27 and 28, 1975.

D. G. Fredlund. *Prediction of Heave in Unsaturated Soils*. Presented to the Fifth Regional Conference, Bangalore, India, 1975.

Measurement of Pollution from Agricultural Areas

under the direction of
Professor T. H. Lackie

This is a feasibility study to assess the correlation of information obtained from air photos and fluorescence intensity analysis of polluted soil and water (i.e. land and water areas affected by runoff from feedlots). If practical aerial surveillance techniques can be developed, the limitations of "ground truth" methods for surveillance currently used could be overcome. This would complement the related project currently underway by the Council to evaluate the design and location of feedlots, and ensure that this industry does not cause undue damage to the environment.

Preliminary work was carried out during the summer of 1975, utilizing the part-time services of a student assistant. Liaison was maintained with G. Lakshman and other members of the staff of SRC.

Some of the preliminary steps undertaken included a retroactive literature search of PAB (pollution abstracts) from 1970 to date; an evaluation of film-filter combinations for detection of fluorescence in water; and some preliminary flights over a local feedlot to try and detect any unusual characteristics of surrounding terrain. Future work planned will include surveillance of areas with a potential problem during the runoff period in the spring of 1976, and more detailed study during the spring and summer period. This study would include examination of other parameters of pollution in addition to fluorescence intensity.

To Study the Causes and Methods of Controlling Riverbank Slope Failures in Southern Saskatchewan

under the direction of
Professor E. K. Sauer

Landslides are widespread in Southern Saskatchewan along the slopes of valleys created by the melting glaciers. Urban development has now extended into these potentially hazardous areas with virtually no control. Furthermore, new roads and bridges are being constructed across and along these valleys. It is imperative, therefore, that these potential failures be analyzed for design and control. Although the mathematical analysis of slope failures is well known, very little is known about the engineering properties of the geological deposits in Saskatchewan. The geological model established by geologists at the Saskatchewan Research Council is being used as a basis for studying these landslides. Graduate student, Moir Haug, working on slope failure in the Saskatoon area.

Publication

A Valley Crossing, Provincial Highway No. 2 at the Arm River: Department of Civil Engineering, IR 6, 26 p.

DEPARTMENT OF DAIRY AND FOOD SCIENCES

Adaptation of the Standard "In Vitro" Forage Digestibility Procedure for Improved Assessment of Unconventional Roughages

under the direction of
Professors R. K. Chaplin, G. A. Jones
and J. F. Mathews

At the present time the Saskatchewan Research Council and some faculty members of the University of Saskatchewan are examining various processing methods for the improvement of low quality forages (straws and wood). Basically the idea is to render the cellulose in the forage more available to the ruminant animal. In order to assess

the relative efficiency of these processing methods it is necessary to have some measure of the extent to which ruminant animals can digest the product. This could be done by animal digestibility trials (*in vivo*) but this is a time consuming and costly procedure. The alternative is to develop some method for use outside the ruminant animal (*in vitro*) which will give a result which can then be used to predict *in vivo* results. The standard method of *in vitro* analysis used for regular forages turns out to be inaccurate when used on the improved straws and wood. The reasons for this discrepancy are not yet understood.

The purposes of this present project are two-fold. One is to better understand the reasons for the failure of the standard *in vitro* method and hence perhaps to modify it to better suit the straws and wood and the second is to develop an alternative *in vitro* method.

Both of these goals are being pursued at the present time. The alternate method under trial is reaction of the sample with commercially available cellulase enzyme. The correlation coefficient between this *in vitro* method and the *in vivo* results is presently 0.71 compared with 0.64 for the standard *in vitro* procedure.

We have been cooperating with Dr. E. M. Coxworth of the Saskatchewan Research Council on this and related studies.

DEPARTMENT OF GEOLOGICAL SCIENCES

Development of Seismic Reflection Methods For Subsurface Mapping in the Precambrian Shield

under the direction of
Professors Z. Hajnal and M. R. Stauffer

The study described here has been undertaken in an attempt to develop the seismic reflection method as a tool for mapping subsurface structures in the complex rocks of the Precambrian Shield and aiding in prospecting for deeply-buried ore bodies. This project can be divided into two phases:

1. developing techniques for obtaining reflections in geologically well-understood rocks,

2. utilizing the techniques in a poorly-understood region or to help in prospecting for an ore body. The first phase is about half completed. In the shield rocks near Flin Flon, Manitoba, reflections have been obtained from a fault zone, a stratigraphic contact and from the horizon containing the Flin Flon ore body. Also, we have identified a near-surface reduction in seismic velocity caused by open fractures in the rock, and have designed shot-hole patterns, seismic-line arrays, and analytical methods that result in significant improvement in the identification of reflective horizons.

Analyses of synthetic seismograms made from the sonic log for the 10,000 ft. deep JXWS hole drilled in the Reynard Lake pluton near Flin Flon, indicates that the three-dimensional shape of this body probably can be mapped.

Considerable work has yet to be done to complete the first phase of the project particularly:

1. the determination of the most efficient shot-hole pattern, shot-hole depth, and explosive charge combinations;

2. the best geophone arrangement;

3. the most suitable part of the energy spectrum to use.

A paper describing the work done to date will be given at the AIME annual meeting, February 22, 1976.

Publications:

Hajnal, Z. and Stauffer, Mel R., 1975, *The application of seismic reflection techniques for subsurface mapping in the Precambrian Shield near Flin Flon, Manitoba*, Can. Jour. Earth Sci., v. 12, n. 12.

Electromagnetic Sounding in Potash Mines

under the direction of
Professors M. S. King and D. J. Gendzwill

The object of this research program is to develop a prototype electromagnetic instrument specifically designed to locate electrically conductive zones in the vicinity of workings in potash mines.

Computer studies of electromagnetic fields in the presence of conducting sheets are being made in the Department of Geological Sciences. These studies will facilitate the design of the proposed instrument to detect salt water or shale beds near openings in potash mines.

Biostratigraphy of the Cretaceous White-Speckled Shales in Saskatchewan

under the direction of
Professor W. G. E. Caldwell

Among the formations of the widespread Upper Cretaceous Series in Saskatchewan, the white-speckled shales are exceptional. They are the most widely used markers for correlation and, as such, they have been useful in assessing collapse structures in the province resulting from the solution and removal of the Prairie Evaporite Formation. They are also economically important, being oil shales in places, potential oil producers in others (as they are producing formations in Alberta), and in others

again they may be the host rocks of uranium concentrations. Members of the Council's Geology Division and of the Saskatchewan Geological Survey rely on the white-speckled shales as stratigraphic and structural markers in their investigations.

The stratigraphy of the white-speckled shales has been much misunderstood. They have been misidentified and miscorrelated largely because they are bounded and divided by planes of erosion (disconformities). Fortunately the white-speckled shales contain assemblages of pelagic foraminiferal fossils, and these are proving invaluable in resolving the stratigraphy. It was by using zones based upon these important fossils that the disconformities first came to be noticed and the stratigraphy in parts of central and eastern Saskatchewan to be resolved satisfactorily.

To document the assemblages of foraminifera upon which the zones are based and to provide a basis for others to use the foraminifera for similar analyses in other parts of the province, the fossils currently are being described systematically. A paper containing the results of the study should be submitted in 1976. Attention is now being focussed on the defining beds — those immediately above and below the white-speckled shale formations.

Professional Research Associate B. R. North and graduate student R. L. McKellar have assisted in the research.

Publication:

North, B. R. and Caldwell, W. G. E., 1975, *Cretaceous Foraminifera from Saskatchewan and Manitoba:* Geol. Survey Canada, Paper 74-38, 35 pp., 3 figs., 12 pls.

DEPARTMENT OF HORTICULTURE SCIENCE

Selection of Late Blooming Saskatoons and Propagation Studies

under the direction of
Professor S. H. Nelson

The work on the grant was initiated in 1974 with the selection of some 133 late blooming types of Saskatoons in large native populations. Low grafting success in mountain ash rootstock necessitated the collection and repropagation of some of these selections in the spring of 1975. This year cotoneaster was used as a rootstock.

In the propagation studies, budding at two dates was carried out on four rootstocks, namely, apple, cotoneaster, hawthorn and mountain ash using two commercial varieties. These results will be available in the spring of 1976.

Saskatoon rooted cuttings have also given considerable difficulty in transplanting. During the summer a number of cuttings was rooted in three types of outdoor intermittent mist propagation beds. The cuttings were graded according to root mass and then transplanted using techniques varying from outdoor planting to overwintering in pots in the greenhouse. Again, the results will be available in the spring of 1976.

In the intermittent mist beds the use of bottom heat or a polyethylene tent over the mist bed to increase the temperature increased both the rooting percentage and the earliness of rooting as shown by the root masses. Hormone applications appeared to be of benefit where no extra heat was used, but their use was not necessary and possibly even detrimental where extra heat was supplied. With cutting size, 5-inch cuttings were superior to 3-1/2-inch cuttings; but it seemed to make little difference whether the basal cut was at a node or not.

Brett Bishop is the graduate student working on this project.

INSTITUTE OF SPACE AND ATMOSPHERIC STUDIES

Solar Ultraviolet Radiation

under the direction of
Professors D. J. McEwen, E. J. Llewellyn
and A. H. Manson

The amount of solar radiation in the 3000-4000A reaching ground level at Saskatoon has been recorded on a regular basis for several months. Of particular interest was the radiation in the 3000-3400A region, due to its potentially harmful biological effects. A large fraction of that reaching the ground is through scattering, and accordingly the zenith sky brightness was monitored. Morphological data were obtained on the sky brightness as a function of season, solar zenith angle and cloud cover.

These measurements were also used to calculate the total ozone abundance, using the Gotz Umkehr method, daily from December 9, 1974 to February 19, 1975.

All of these measurements will provide valuable background base values to which current on-going measurements of both solar UV reaching the ground and ozone abundance can be compared. Of concern are possible long term changes due to perturbations of the ozone layer which as yet are only speculated, owing to lack of definitive measurements.

These ground based studies were augmented during the summer of 1975 by solar UV measurements from three AES balloons launched from Yorkton. There a similar type of spectrometer scanned the direct solar spectrum from 1850A to 3100A and measurements of ozone content above the balloon were obtained for comparison with total ozone content measured from the ground. On one

of these flights continuous measurements of ozone content above the balloon were obtained for comparison with total ozone content measured from the ground. On one of these flights continuous measurements were obtained during the controlled descent of the balloon near Moose Jaw. These will provide a more complete picture of the absorption of the UV solar radiation and the ozone height profile.

Ground based observations will continue on a more routine basis with the planned construction of a recording photometer. Technical assistance is being provided by Mr. H. T. Meredith. Dr. A. Y. Ung has been associated with the project and Mr. L. Murdock has contributed materially to the data analysis and interpretation.

Publications:

L. B. Murdock, 1975. *Solar Ultraviolet Radiation and Atmospheric Ozone*. Bachelor of Engineering Thesis, University of Saskatchewan.

Co-ordination of Canadian Participation in The International Magnetospheric Study (1976-78)

under the direction of
Professor B. W. Currie

The co-ordinator (B. W. Currie) decided that the grant should be spent on IMS-related projects of some direct concern to Saskatchewan. The most obvious ones are:

1. solar-terrestrial weather relationships;

2. earth-current potentials which can lead to outages in electric power distribution systems, especially at middle and high latitudes. A postdoctoral fellow is currently testing the conclusions from a very extensive literature about the former to see to what extent they are applicable to the yearly and seasonal weather of the Prairie Provinces. Possibilities of establishing an observational program for the latter are still being explored.

Numerous investigations during the past 50 years have indicated periodic variations of annual and seasonal precipitation and temperature that correlate with the sunspot cycles of about 11.5 and 23 years. However, the possibility of using the sunspot cycles as a means of forecasting annual and seasonal weather and, particularly, the resultant agricultural productivity has been neglected until recently. The two major reasons follow. While sunspot numbers are an excellent indicator of the intensity of the solar wind, consisting of electrons and protons ejected into interplanetary space by solar flares and related disturbances on the sun, the particle energy penetrating into our atmosphere is very minimal compared with the heat energy incident on the atmosphere. No apparent physical mechanisms are known by which small amounts of incident particle energy can influence weather systems. Other reasons involved a lack of systematic global studies of the climatic variations with respect to the solar cycles. For some regions there was apparently a positive correlation, others a negative correlation, and still others no correlation.

The International Magnestospheric Study may resolve the mechanisms by which the particle radiation from the sun can affect terrestrial weather, and regions where they may be the most significant. The Canadian Prairies is one of these regions. The most intense penetrations of solar particles into the atmosphere takes place where auroras are observed most frequently, the zones of maximum auroral frequency. The zone for the northern hemisphere crosses Canada by way of northern Quebec, Churchill, Yellowknife and Dawson. For all other countries, the zone for the northern hemisphere "skirts" their northern borders.

Papers by A. Thomson (1936) and R. E. DeLury (1938) showed a tendency for yearly precipitation and temperature to be higher at sunspot minimum than at sunspot maximum, using weather records for Calgary, Edmonton and Prince Albert dating from 1883. B. W. Currie in 1953 repeated their studies, using precipitation and temperature data for Winnipeg, Regina and Edmonton. This study verified the previous conclusions — indicating about a 15 per cent higher precipitation in the years centered on sunspot minima than for years centered on sunspot maxima for 7 sunspot cycles or about 75 years. The aforementioned postdoctoral fellow has extended this study up to 1974 using weather data for Calgary, Edmonton, Regina, Saskatoon and Winnipeg. The average annual variations of precipitation and temperature still persist. A more detailed study of seasonal precipitation and of periods with below normal and above normal precipitation is now in progress, using sunspot numbers and the so-called geomagnetic character numbers. The latter are derived from the observed ranges of magnetic disturbance at selected observatories. The methods used in the study are essentially those used in a number of recently published papers which have lead to widespread interest in the possibility of using variations in solar corpuscular radiation for predicting seasonal climate, and for improving weather forecasts covering several days. Brief summaries of the conclusions from two review papers (just published) follow. They demonstrate the need for both detailed studies of regional variations and for resolving the physical mechanisms in our magnetospheric environment that lead to them.

One study of atmospheric pressure anomalies by USSR investigators (reviewed by Mustal) shows significant variations in atmospheric pressures at higher latitudes centered on a 4-day period following the impact of a corpuscular stream on the magnetosphere. If further studies establish the existence of these anomalies beyond all question it could lead to a significant improvement of weather forecasts over periods of 2 to 5 days.

Another review paper (J. W. King) brings together the results of a number of recent studies on sun-weather relationships (including several of his own). The conclusions follow.

1. The northern hemisphere vortocity index (a measure of weather cyclonic activity) shows a definite and significant variation (about 10 percent oscillation) from 2 to 4 days following notable changes in the impingement of solar corpuscular particles on the magnetosphere.
2. Between 70° and 80° N a positive correlation with sunspots (maximum sunspots - maximum precipitation)
3. Between 60° and 70° N a negative correlation (maximum sunspots - minimum precipitation; a
4. Between 50° and 60° N from 1890 to 1920, maximum sunspots - minimum precipitation; a reversal in some regions from 1920 - 1973 to maximum sunspots - maximum precipitation.
5. Lower latitudes notable changes from normal precipitation in years centered on sunspot extremes.

King argues that the decrease in the past 2 or 3 years in world food production is related to the occurrence of the sunspot minima in 1974-75 and the consequent decrease in precipitation in certain regions which are large producers of food products. It should be noted that the long-time record for our Prairie provinces shows above normal precipitation for minimum sunspots. And an explanation can be offered, if the variations are induced by solar corpuscular radiation. The zone of maximum penetration of the solar particles into the atmosphere is farther south over Canada than for any other food-producing country in the northern hemisphere, so that conclusion (3) in the above listing is probably applicable to our Prairie provinces.

Our current examination of climatic variations of the Prairie provinces with respect to various indicators of solar activity should provide a guide both to our future production of food products and to world markets for them. If the International Magnetospheric Study does establish physical mechanisms relating weather and climatic changes to variations in solar corpuscular radiation, the value of our current studies would be greatly enhanced. They could then be included with confidence in planning agricultural operations in our Prairie provinces.

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THE SASKATCHEWAN RESEARCH COUNCIL

FINANCIAL STATEMENT

Year Ended March 31, 1975

To the Directors of
The Saskatchewan Research Council

AUDITOR'S REPORT

Pursuant to Section 20 of The Research Council Act, being Chapter 406 Revised Statutes of Saskatchewan, 1965, I have examined the balance sheet of The Saskatchewan Research Council as at March 31, 1975, and the statement of operations and operating surplus for the year then ended. My examination included a general review of the accounting procedures and such tests of accounting records and other supporting evidence as I considered necessary in the circumstances.

I am unable to verify unbilled shareable costs reported under that caption on the balance sheet as the eligibility of expenditures incurred under the Federal-Provincial cost sharing agreement for the fiscal period April 1, 1974 to March 31, 1975 has not been reviewed by Federal authorities.

In my opinion, subject to any adjustments to unbilled shareable costs and to operating surplus which may occur after the eligibility of expenditures incurred has been reviewed, these financial statements present fairly the financial position of the Council as at March 31, 1975 and the results of its operations for the year then ended, in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Regina, Saskatchewan
August 22, 1975

W. G. Lutz, C.A.,
Provincial Auditor

THE SASKATCHEWAN RESEARCH COUNCIL

NOTES TO FINANCIAL STATEMENTS

March 31, 1975

1. Accounting Policies:

Fixed Assets

(a) The Council follows the policy of charging the current year's revenue with the full cost of all fixed assets purchased during the year. Only those items with a cost of $100 or more are recorded in the fixed asset accounts.

(b) The Council's policy on removals from fixed assets is to remove all equipment which has:

— become obsolete during the year
— been sold during the year
— been in service for ten years.

2. Unbilled Shareable Costs:

Under the terms of a two year agreement with the Federal government agency administering the Agricultural Rehabilitation Development Act, the Council has incurred expenditures of $896,939 in the fiscal period April 1, 1972 to March 31, 1974. The agreement allows the Council to recover from the Federal government agency, one-half of all eligible expenditures.

As at March 31, 1975 the Council had received all but $80,535 of the total $448,470 recoverable.

A supplementary agreement has been signed that will extend the Brackish Water Purification project from April 1, 1974 to March 31, 1978.

For the fiscal year ended March 31, 1975, the Council incurred approximately $100,000 of expenditures on this project that is included in Statement 4 (Statement of Expenditures).

One-half of this amount, approximately $50,000 has been recorded by the Council as recoverable from the Federal government agency.

M121

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Statement 1

THE SASKATCHEWAN RESEARCH COUNCIL

BALANCE SHEET

March 31, 1975
(with comparative figures at March 31, 1974)

ASSETS

	1975	1974
Current:		
Cash	$ 22,354	$ —
Guaranteed savings deposit	10,692	102,599
Accounts receivable	242,561	265,420
Unbilled shareable costs (Note 2)	139,668	273,665
Prepaid expenses and deposits	21,170	11,805
Provincial grant receivable	—	54,996
Total current assets	$ 436,445	$ 708,485
Investments — Cost	$ 60,000	$ 60,000
Equity in Saskatoon Co-operative Association	$ 201	$ 201
Fixed — Cost (Note 1)		
Laboratory equipment	$ 639,386	$ 650,252
Automotive equipment	151,923	114,909
Building	81,000	81,000
Furniture and fixtures	106,632	94,086
Shop equipment	40,716	48,059
Land	10,000	10,000
	$1,029,657	$ 998,306
	$1,526,303	$1,766,992

LIABILITIES AND EQUITY

	1975	1974
Current:		
Bank overdraft	$ —	$ 125,811
Accounts payable	155,135	172,981
Employee deductions payable	47,772	40,414
Deferred revenue and client deposits	46,000	47,818
Total current liabilities	$ 248,907	$ 387,024
Equity:		
Equity in fixed assets (Statement 2)	$1,029,657	$ 998,306
Operating surplus (Statement 3)	247,739	381,662
	$1,277,396	$1,379,968
	$1,526,303	$1,766,992

(see accompanying notes to financial statements)

Statement 1

THE SASKATCHEWAN RESEARCH COUNCIL

BALANCE SHEET

March 31, 1975
(with comparative figures at March 31, 1974)

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	$1.526.303	$1 766 992

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	$1.277.396	$1 379 968
	$1.526.303	$1 766 992

(see accompanying notes to financial statements)

Statement 2

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EQUITY IN FIXED ASSETS

Year Ended March 31, 1975
(with comparative figures for the year 1974)

	1975	1974
Equity in fixed assets beginning of year	$ 998,306	$ 882,310
ADD		
Fixed asset additions (Statement 4)	108,986	169,906
	$1,107,292	$1,052,216
DEDUCT		
Fixed asset disposals		
— written off (Note 1)	$ 72,805	$ 50,012
— sold	4,830	3,898
Equity in fixed assets end of year	$1,029,657	$ 998,306

(see accompanying notes to financial statements)

Statement 3

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF OPERATIONS AND OPERATING SURPLUS

Year Ended March 31, 1975
(with comparative figures for the year 1974)

	1975	1974
Revenue		
Province of Saskatchewan		
— grants	$1,600,000	$1,212,266
— Departmental contracts	540,233	653,659
	$2,140,233	$1,865,925
Government of Canada		
— Departmental grants	$ 122,407	$ 114,000
— Departmental contracts	51,541	180,053
— Cost sharing agreement	49,938	248,665
	$ 223,886	$ 542,718
Industry		
— grants	$ 10,000	$ 10,000
— fees for services	410,079	294,767
	$ 420,079	$ 304,767
Investment income	$ 12,227	$ 11,596
Proceeds on disposal of fixed assets	2,219	3,625
Other income	2,501	16,614
Total Revenue	$2,801,145	$2,745,245
Expenditures (Statement 4)	$2,826,218	$2,604,682
Research Grants (Statement 5)	108,850	81,486
	$2,935,068	$2,686,168
Surplus (Deficit)	$ (133,923)	$ 59,077
Operating surplus, beginning of year	381,662	322,585
Operating surplus, end of year	$ 247,739	$ 381,662

(see accompanying notes to financial statements)

Statement 2

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EQUITY IN FIXED ASSETS

Year Ended March 31, 1975
(with comparative figures for the year 1974)

	1975	1974
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ADD:		
Fixed asset additions (Statement 4)	108,986	169,906
	$1,107,292	$1,052,216
DEDUCT:		
Fixed asset disposals		
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— sold	4,830	3,898
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(see accompanying notes to financial statements)

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(see accompanying notes to financial statements)

Statement 4

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EXPENDITURES

Year Ended March 31, 1975
(with comparative figures for the year 1974)

	Admin.	Chem.	Eng.	Geology	Industrial	Physics	1975 Total	1974 Total
Employee benefits	$ 18,122	$ 15,864	$ 19,917	$ 19,502	$ 9,254	$ 14,084	$ 96,743	$ 63,121
Fixed asset purchases	5,237	9,607	34,844	42,629	6,757	9,912	108,986	169,906
Other	97,490	12,746	38,811	64,841	22,680	18,205	254,773	206,092
Salaries	141,383	275,113	398,117	360,306	138,156	270,583	1,583,658	1,279,731
Supplies	14,248	15,797	34,215	70,834	20,637	23,244	178,975	131,527
Technical Services	38,531	(21,959)	60,938	400,271	10,037	(13,628)	474,190	657,135
Travel and vehicle operation	9,674	8,229	28,734	59,524	9,538	13,194	128,893	97,170
	$324,685	$315,397	$615,576	$1,017,907	$217,059	$335,594	$2,826,218	$2,604,682

(see accompanying notes to financial statements)

Statement 5

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF GRANTS FOR RESEARCH PROJECTS

Year Ended March 31, 1975

	1975	1974
University of Saskatchewan		
Seismic Reflection — Subsurface Mapping	$ 5,600	$ —
Production of New Crops and Products	4,000	—
Selection and Propagation of Saskatoons	4,170	—
Sedimentary Strata of the Prairies	—	900
Helium-4 Mass Spectrometry for Uranium Exploration	—	1,459
Pollution of Soil, Water, etc. by Pesticide Residues	—	5,000
Photochemical Degradation of Pesticides, etc.	—	3,000
Hydrogen Reduction of Sodium Sulphate	—	3,233
Field Studies of Microseismic Energy Emission	3,500	3,817
Soil Contamination and Crop Damage from Potash Refineries	25,304	14,033
Fate of KCl Dustfall	14,000	—
Research in Fluid-Solids Systems	4,000	3,500
Stratigraphic Studies in Cretaceous Rocks	3,500	2,602
Chemical Analysis of Birch Bark	3,500	3,000
Study of Foundation Conditions in Downtown Area of Saskatoon	1,260	2,990
Proterozoic Archean Contract in the Vicinity of Hanson Lake Road	—	3,444
Remote-sensing of Moisture Stress, Weed Composition, and Salt Accumulation	—	3,067
Programming Additions to the Geographic Information System to Facilitate Use with Geophysical and Geological Data	1,350	1,350
Peas and Faba Beans in Milk Replacers for Calves	4,000	3,019
Culture of Medicinal Plants	—	1,956
Petrology and Stable Isotope Geochemistry of the Boundary Intrusions, etc.	1,000	1,424
Utilization of Fly Ash in the Treatment of Pulp and Paper Mill Effluents	4,844	3,004
Geotechnical Analysis of a Valley Crossing at Arm River	—	3,000
Milk Manufacturing in Saskatchewan	2,450	1,976
Fertility and Cultural Studies with Irrigated Vegetable Crops	3,927	3,712
Solar Ultraviolet Radiation	4,945	—
Landslides — Urban Areas in Southern Saskatchewan	3,000	—
	$ 94,350	$69,486
University of Regina		
Thermal Properties of Salts	$ 3,000	$ 3,000
An Evaluation of the Origins of Iron Bacteria found in Saskatchewan Soils and Water	5,900	4,500
Analytical & Physico Chemical Studies on Herbicides	3,600	3,000
Preliminary Study of Alkali and Alkali Earth Metals in Evaporites	—	1,500
Urban Hydrology of Saskatchewan City	2,000	—
	$ 14,500	$12,000
Total	$108,850	$81,486

Statement 4

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EXPENDITURES

Year Ended March 31, 1975
(with comparative figures for the year 1974)

	Admin.	Chem	Eng.	Geology	Industrial	Physics	1975 Total	1974 Total
Employee benefits	$ 18.122	$ 15.864	$ 19.917	$ 19.502	$ 9.254	$ 14.084	$ 96.743	$ 63.121
Fixed asset purchases	5.237	9.607	34.844	42.629	6.757	9.912	108.986	169.906
Other	97.490	12.746	38.811	64.841	22.680	18.205	254.773	206.092
Salaries	141.383	275.113	398.117	360.306	138.156	270,583	1.583.658	1.279.731
Supplies	14.248	15.797	34.215	70.834	20.637	23.244	178.975	131.527
Technical Services	38.531	(21.959)	60.938	400.271	10.037	(13.628)	474.190	657.135
Travel and vehicle operation	9.674	8.229	28.734	59.524	9.538	13.194	128.893	97.170
	$324.685	$315.397	$615.576	$1.017.907	$217.059	$335.594	$2.826.218	$2.604.682

(see accompanying notes to financial statements)

Statement 5

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF GRANTS FOR RESEARCH PROJECTS

Year Ended March 31, 1975

	1975	1974
University of Saskatchewan		
Seismic Reflection — Subsurface Mapping	$ 5,600	$
Production of New Crops and Products	4,000	
Selection and Propagation of Saskatoons	4,170	
Sedimentary Strata of the Prairies	—	900
Helium-4 Mass Spectrometry for Uranium Exploration	—	1,459
Pollution of Soil, Water, etc. by Pesticide Residues	—	5,000
Photochemical Degradation of Pesticides, etc.	—	3,000
Hydrogen Reduction of Sodium Sulphate	—	3,233
Field Studies of Microseismic Energy Emission	3,500	3,817
Soil Contamination and Crop Damage from Potash Refineries	25,304	14,033
Fate of KCl Dustfall	14,000	—
Research in Fluid-Solids Systems	4,000	3,500
Stratigraphic Studies in Cretaceous Rocks	3,500	2,602
Chemical Analysis of Birch Bark	3,500	3,000
Study of Foundation Conditions in Downtown Area of Saskatoon	1,260	2,990
Proterozoic Archean Contract in the Vicinity of Hanson Lake Road	—	3,444
Remote-sensing of Moisture Stress, Weed Composition and Salt Accumulation	—	3,067
Programming Additions to the Geographic Information System to Facilitate Use with Geophysical and Geological Data	1,350	1,350
Peas and Faba Beans in Milk Replacers for Calves	4,000	3,019
Culture of Medicinal Plants	—	1,956
Petrology and Stable Isotope Geochemistry of the Boundary Intrusions, etc.	1,000	1,424
Utilization of Fly Ash in the Treatment of Pulp and Paper Mill Effluents	4,844	3,004
Geotechnical Analysis of a Valley Crossing at Arm River	—	3,000
Milk Manufacturing in Saskatchewan	2,450	1,976
Fertility and Cultural Studies with Irrigated Vegetable Crops	3,927	3,712
Solar Ultraviolet Radiation	4,945	—
Landslides — Urban Areas in Southern Saskatchewan	3,000	—
	$ 94,350	$69,486
University of Regina		
Thermal Properties of Salts	$ 3,000	$ 3,000
An Evaluation of the Origins of Iron Bacteria found in Saskatchewan Soils and Water	5,900	4,500
Analytical & Physico Chemical Studies on Herbicides	3,600	3,000
Preliminary Study of Alkali and Alkali Earth Metals in Evaporites	—	1,500
Urban Hydrology of Saskatchewan City	2,000	—
	$ 14,500	$12,000
Total	$108,850	$81,486